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INSTRUMENTS

INDUSTRIAL — SCIENTIFIC

Devoted to the Instrument Problems of all Industries

Vol. 1. No. 6 Pittsburgh, Pa. June, 1928

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A Device for Measuring Brittleness of Rubber and Gutta Percha Compounds.
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A Proposed Automatic Spectrum Analyzer.
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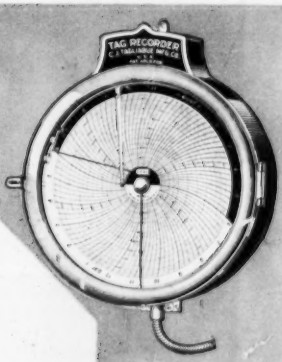

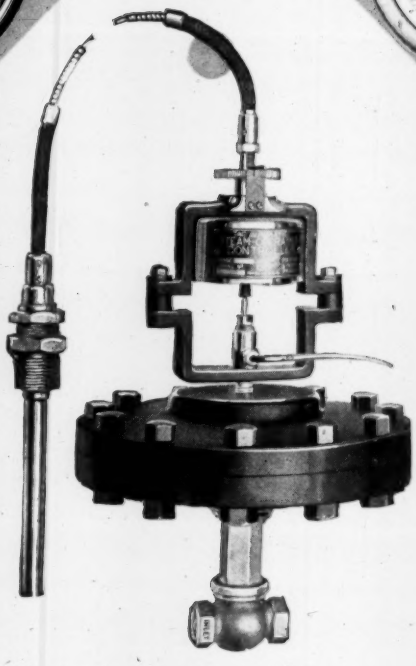

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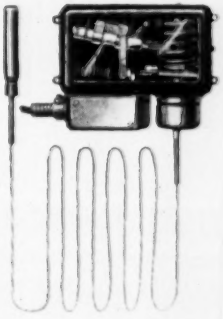

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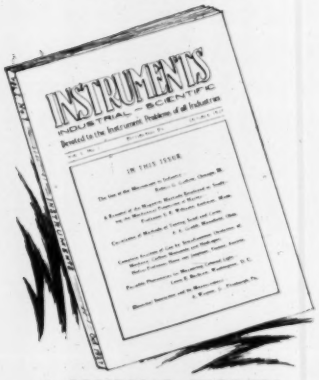

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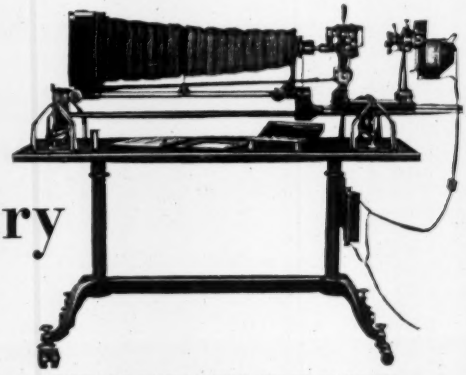

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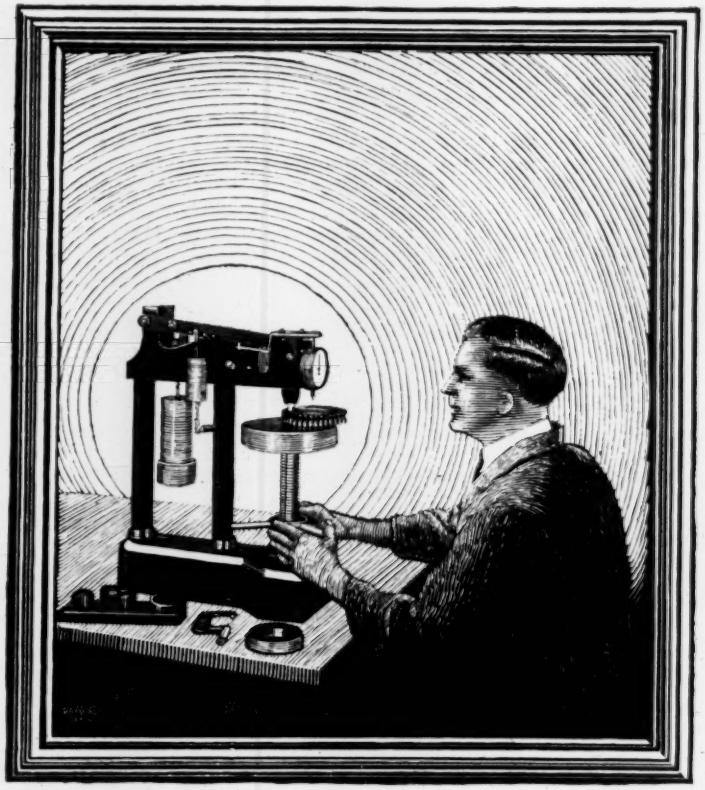

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Vol. 1. No. 6. JUNE 1928 Pittsburgh, Pa.

To Our Readers

IN the New Instrument Section of INSTRUMENTS, an attempt is made to cover all new developments in the field of engineering instruments.

This section does not require that the instrument operate on a wholly new principle, never before used. It covers the new instruments made by the manufacturer never made by him before; or radical improvements or changes in instruments previously made by him.

The articles in this section are about 1000 words in length, including illustrations. The reason for this is that all articles in INSTRUMENTS start on the right hand page, and as each page has approximately 500 words, the article will end on the bottom of the left hand page.

In many cases readers of technical papers do not save their periodicals but on receiving the paper leaf through it and tear out advertisements and articles of interest to them. These are not read by them immediately but are filed under subject headings for future reference.

This arrangement is an innovation in the handling of such editorial material. One of our advertisers writes as follows:

> "I think your plan in publishing articles of this description is a real benefit, both to the reader and to the manufacturer, as it supplies the reader with accurate data relative to available meters and to the manufacturer a very valuable feature of the necessary publicity to establish his products."

From an editorial standpoint these articles are just as important as any other information contained in the journal.

The editor takes this opportunity to again point out the necessity for readers mentioning INSTRUMENTS in their dealings with instrument companies. Two cases came to the attention of the editor within a week, in which orders for instruments had been placed with advertisers in INSTRUMENTS but no mention was made on the order or otherwise that the information had been obtained through this journal. Soon after one of these advertisers cancelled his contract, stating that he had not received the return from his advertising he expected.

It is sad that there must be a commercial side to all efforts of this nature. The instrument companies also must continually keep the commercial side before them; for while they are performing a labor of love, they cannot operate at a loss. A very considerable amount of money is

invested by them each year in advertising and this investment must show returns. The value of a publication to the advertiser is estimated by the number of inquiries and orders they receive as a result of their sales message in that publication.

In approaching instrument companies for further information on anything you see in this journal, kindly mention INSTRUMENTS. You will be performing a service to the manufacturer as well as to INSTRUMENTS.

———— :: ————

Co-operation for Instruments

MANY developments in science and industry are limited by the lack of instruments or lack of knowledge of the available instruments. There are industrial and technical processes that cannot be used efficiently as the instruments necessary for their control are not available. Conversely, there are instruments on the market that doubtless would find application in fields other than those in which they were developed, were their possibilities pointed out.

The development and improvement of instruments and measuring devices is of intimate concern to every user and builder of instruments. It is self-evident that the closer these two groups, user and maker, come together the better will their respective interests be served.

Cooperation of all interested in the development and application of instruments must exist to accomplish maximum results. It will require on the one hand making known new needs and on the other extending information on instruments already developed.

INSTRUMENTS endeavors to promote cooperation between the users and the manufacturers. The Editorial Columns and Information Section are thrown open to the user to make known his needs. The maker can extend the information on the instruments already developed by him in the New Instrument Section and the Advertising Pages.

———— :: ————

Summer Vacations

VACATIONS and leisure time often produce more constructive ideas than the same length of time spent on the job. Like the man who was so close to the trees that he couldn't see the forest; many of us are so close to the job that it's hard to imagine new or better ways of using instruments.

Vacation time for the most of us is approaching. A lot of new ideas will probably pop up while we are calmly wrapping a worm on a hook; ideas for the use of instruments to improve processes. The question now is—What use can we make of them in our business?

Or, if you make a trip by train or automobile—You will notice the signs along the way and in the towns you pass through. Each is an ad-

vertisement carrying a message, that, at least, causes you to think for a moment.

It will pay you to take your copy of INSTRUMENTS along with you and to look through the advertisements. Each one brings you a message, new ideas—give them a moment of your time.

::

To the Instrument Companies

IN order to keep the readers of INSTRUMENTS in touch with the latest developments in industrial and scientific instruments, the editor again urges all manufacturers of such instruments to keep him informed of all new instruments or important improvements made by them as soon as they appear, by letting him have descriptions of about 1000 words including construction, performance, and applications.

::

X-Ray Inspection

THE manufacturers will doubtless find routine X-ray examination a practical aid in the guarantee of material quality. It can be put to work to effect savings in production. The user of the products is the one who will be benefited most by the examination of defects that often result in expensive failures.

This method has the very appreciable advantage that the inspection, which is non-destructive, can be made on rough castings, forgings, etc., thus locating defects before time and money are lost in machining and working.

In this issue, we present an article on the subject of X-ray metal testing. The value of X-rays as an engineering tool is not confined to metals by any means.

::

When writing for literature or for information on products or articles which you have seen in INSTRUMENTS, be sure that you give the address as shown in the publication. These addresses are usually keyed. It has been called to our attention that several companies wrote pertaining to instruments appearing in the new instrument section giving an address which was evidently copied from another journal or trade directory. Instruments would have received no credit for these but fortunately, it happened to be the only journal in which this article appeared and we were able to check this through the courtesy of the advertiser.

::

"Cooperation is not a sentiment—it is an economic necessity."—Charles Steinmetz.

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Historical Sketches of Men who have contributed to the advancement of the Instrument Science.
Indicating and Integrating Ground Speed Indicator.
The Geodetic Level Rod, Its Design and Methods of Construction.
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Thermoradiometers.
Mechanical Vibrations and Their Measurement.
Instruments to improve Diesel Engine Efficiency.
Comparison of Instruments for Measuring Hardness.

The Determination of the Parallelism of the Measuring Surfaces of Measuring Tools

*Prof. Dr. G. Berndt, Dresden, Germany**

A. Introduction. To determine length in practice, one very often carries this out by placing the piece to be measured on a permanent, level surface and places a second level surface against it on the other side. Examples of such devices with two plane surfaces facing each other are: vernier calipers; amplifying gauges; dial gauges, which are set in a frame (like the passameter); measuring machines; and micrometers. With the latter—contrary to all other mentioned devices—the movable measuring surface is not simply moved parallel to itself, but is simultaneously rotated in its plane.

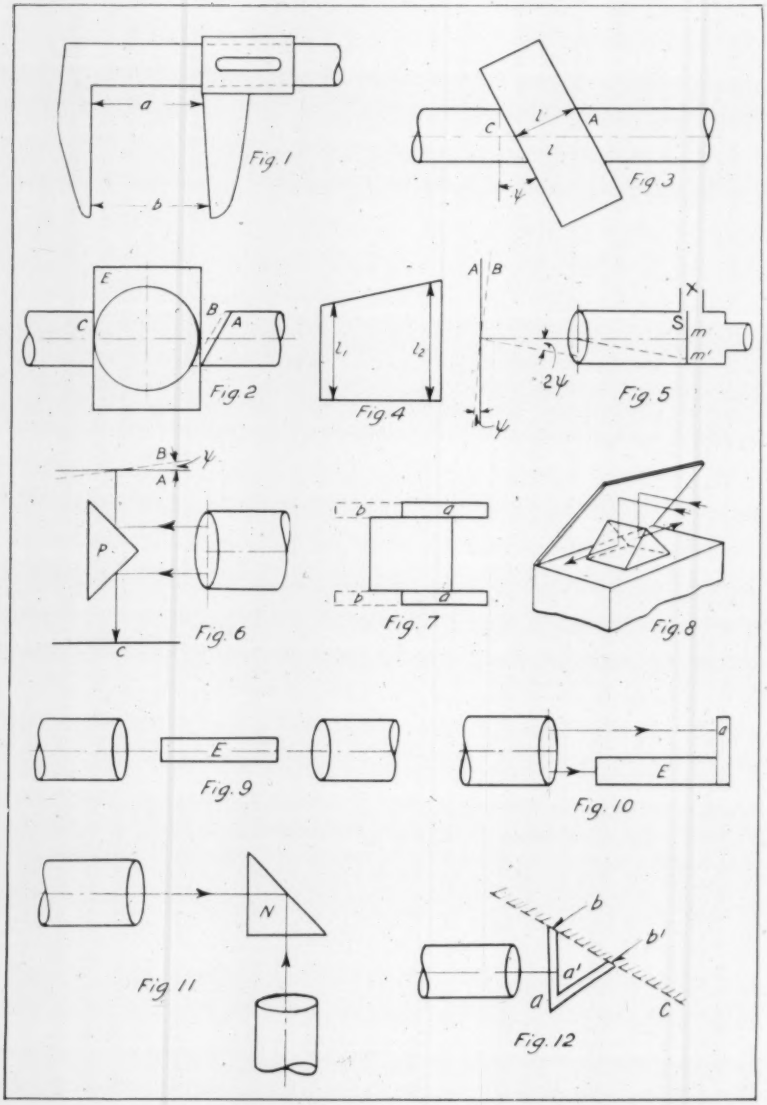
With the vernier calipers the jaws are generally of considerable length, so that the measurement of small pieces can be carried out at different distances from the slide bar. To prevent obtaining therewith different values of a and b (Fig. 1), the measuring surfaces of the jaws must be parallel within the limits of accuracy required.

With the rest of the instruments the diameters of the measuring surfaces in most cases vary between 4 and 8 mm, so that the measured piece with plane surfaces all extend beyond them. Round bodies (cylinders, balls) are placed as close as possible to the center of the measuring surfaces. These measuring tools are either set with gauge blocks (measuring machines) or standardized by means of end measuring rods (micrometers, dial gauges, amplifying gauges) and their zero position is also checked by bringing the two measuring surfaces together. The setting with a rectangular standard E (Fig. 2) gives a position A. This remains the same, if E is a cylinder, whose axis lies in the plane of the sketch. If though it is perpendicular to this, the movable measuring surface must be brought to the position B. So that to obtain the same quantity in both cases, the two measuring surfaces A and C must be parallel to one another.

In addition it should be mentioned, that the measuring surfaces A and C should also be perpendicular to the axis, as one would otherwise not measure the length l' (Fig. 3) but its projection l and so have an error $l - l' = L\,(1 - \cos \Psi) = \frac{1}{2}\, l\, \Psi^2$, which therefore is of the second order, while that due to the non-parallelism of the measuring surfaces enters into the result with the first order, as can be seen from Figs. 1 and 2.

The same requirements in regard to parallelism of the measuring surfaces hold also for the corresponding standard and limit snap gauges, and

*Institut fuer Messtechnik der Technischen Hochschule.



finally also for the gauge blocks, as they otherwise would not embody a definite length but this could vary from l_1 to l_2 (Fig. 4). The gauge blocks though must be considered specially as regards the determination of the parallelism of their measuring surfaces, as these are not turned toward one another but away from one another.

B. Determination of the Parallelism of Measured Surfaces Turned Towards One Another (vernier calipers, amplifying gauges, dial gauges, micrometers, measuring machines, snap gauges).

a. Light Slit. If the two measuring surfaces can be brought together, the simplest is to observe the light slit set up between them. As the measuring surfaces in most cases are not highly polished and also have a certain width, one can therefore estimate the size of the smallest light slit still visible to the naked eye to about 5 μ (1 micron or 1 μ=1/1000 mm), while with the use of a magnifying glass of suitable magnification down to about 1 μ. This method is recommended only for vernier calipers, where this accuracy is always sufficient. In doing so one must meanwhile be careful that the measuring jaws are brought together with the usual measuring pressure (which tests have determined as about ¾ kg.), in order to control the parallelism of the jaws under the same conditions as used as they always bend up to a certain degree. With jaws not completely pushed together the light slit will run somewhat convergent from the slide bar toward the jaw ends.

In addition to the frequent deficiency of the method—insufficient accuracy—the parallelism can only be observed for one position, the zero setting and it also gives no numerical values as to the size of the non-parallelism.

b. Measurement of the Distance by End Measuring Rods, Balls, etc. These disadvantages can be avoided, if one uses end measuring rods, internal cylindrical gauges or steel balls at different places of the measuring surfaces (in Fig. 1 for example a and b). This method though can only be used with vernier calipers, as with the other instruments the measuring surfaces are too small for this and also in addition with amplifying gauges, micrometers and measuring machines the direction of pressure does not fall in the direction of the axis, whereby an oblique setting of the measuring surfaces is occasioned.

c. Measurement of the Distance by Inside Test Indicator. The same considerations hold also for the measurement of the distance of different points of the measuring surfaces by means of the inside test indicator. This method therefore can likewise only be used for vernier calipers, if care is taken, that the measuring pressure of the inside test indicator is equal to that used in actual practice, that is about ¾ kg. On the other hand though it permits the determination of the parallelism for various settings of the jaws (for which namely the horizontal optimeter with its inside measuring arrangement has proven satisfactory). The measurement by means of the inside test indicator further is suitable for the determination of the parallelism of the measuring surfaces of snap gauges, but with these one also must choose the measuring pressure, so that the bending open is the same as in actual practice, which often is not possible to attain.

d. Interference. A very exact test for the parallelism of measuring surfaces is permitted by the observation of the interferences of the same thicknesses, which occur between any one measuring surface and the surface of a parallel plate (optical flat) of glass or quartz. The optical flat

is laid on the solid measuring surface and the other is brought against it with the usual measuring pressure. The optical flat is then moved back and forth, that is as parallel as possible to the one measuring surface (at best the solid), which can be recognized, in that the interference bands wholly disappear, or—in case the surface is not wholly plane—form closed curves. One then counts the green interference bands (p) which are simultaneously visible on both measuring surfaces. As the thickness of a wedge from one band to the next increases by half a wave length, with green light about 0.25 u, the non-parallelism can easily be calculated. Thereby one must meanwhile still be careful, that the last visible interference band is not right on the edge of the measuring surface (respectively the part coming into consideration after the deduction of the edge slope). As an average, one therefore adds one band to the number p of the visible bands on each measuring surface. According to this the non-parallelism can be set equal to $\pm \frac{1}{2} (p + 2)\ 0.25\ u = (p + 2)\ 0.125\ u$.

This method has the advantage, that it permits determining the parallelism in the operating condition, whereby the measuring surfaces to a certain degree straighten out to one another. It permits though on the other hand determining the parallelism only for those places, for which suitable optical flats are available. This can be helped to some extent, in that one forces 2 optical flats onto a good steel gauge block of the proper size and then uses the whole combination as above. With very good guidance of the movable measuring surface, one can in an emergency be content with testing one position; with micrometers it must be carried out for several positions within one full revolution—due to the turning of the measuring surface—therefore a set of 4 to 5 correspondingly stepped optical flats must be available.

A further disadvantage is that the result depends upon the skill and experience of the observer and due to this may show somewhat different values with different observers. This method cannot in general be used for snap gauges and also not, if the measuring surface is only ground and not polished. It therefore ordinarily does not enter into consideration for vernier calipers, with which in addition also the demands on the parallelism are considerably less, but is used with amplifying gauges, micrometers and measuring machines.

e. Auto-Collimating Telescope. The measurement of parallelism with the auto-collimating telescope is based on the principle shown in Fig. 5. In the lower half of the cross lined plate S (which is covered toward the eye), illuminated by the lamp L is found a mark (line). The rays going out from this leave the objective O as a parallel bundle of rays (as S is in its focus) and fall on the reflecting surface A, which in the plane of the drawing stands perpendicular to the telescope axis, while the perpendicular to it has a very slight inclination. The rays are then thrown back in the plane of the drawing perpendicular to themselves and there occurs

(due to the slight inclination) in the other half of the cross-lined plate S an image of the mark, exactly beside it at m. If now A in the plane of the drawing is turned through an angle Ψ to the position B, the rays are thrown back by it turned through an angle 2Ψ and the image of the mark moves to m'. If the distance $m - m' = s$ is measured by means of an optical micrometer, the following equation holds: $\tan 2\Psi = s/f$ (in which f denotes the focal length of the objective) and with sufficient accuracy, as in every case the angle is small.

$$\Psi = s/(2f) \text{ in circular measurement}$$
$$\Psi = s/(2f \times 4.85 \times 10^{-6}) \text{ sec.}$$
$$\Psi = 1.031 \times (s/f) \times 10^{5} \text{ sec.}$$

With a micrometer pitch of 0.5 mm. and 100 divisions (T) of the drum and a focal length $f = 500$ mm., each division on the drum would denote 1.03 sec., so that with an estimate to 1/10 T, one can measure to about 1/10 sec. With a size of flat of 10 mm. there would exist between A and B a difference of ± 0.0025 μ. This precision or reading cannot be used in most cases though, on account of insufficient planeness of the surfaces. There resulted in fact with a telescope having a $f = 400$ mm. focal length and $1T = 2.6$ sec. (so that ¼ sec. could be easily estimated) with repeated settings on a good plane surface (gauge block) a deviation of ± 0.3 T and an average error of the arithmetical means of ± 0.06 T (0.15 sec.). With less accurate surfaces as are mostly shown by micrometers, the errors increase on the other hand to 1.3 to 2.6 sec. therefore ten to twenty times; on an average therefore the non-parallelism can be determined to about ± 0.05 μ. For this reason it is advisable not to go above a focal length $f = 200$ mm. in practice, as the accuracy of the angle measurement only decreases proportional to f, the sharpness of the setting though increases proportional to $1/f^2$.

In order to avoid the necessary knowledge of the focal length f to convert the drum dimensions into seconds and to include the errors of the screw, it is best to calibrate the optical micrometer directly in angle seconds. For this purpose one sets a gauge block on a sine bar, which gives certain determined inclinations by placing different gauge blocks underneath it. For the above mentioned telescope there resulted $1T = 2.58$ sec. with a maximum error of ± 0.4 sec. and an average error of about ± 0.2 sec. therefore about 0.8%.

In order also to measure the non-parallelism in the direction perpendicular to the plane of the drawing, one turns either the piece tested or more convenient the telescope 90 degrees.

To determine the non-parallelism of surfaces A and C facing each other (Fig. 6) one sets a 90 degree steel prism or a glass prism P with silvered surfaces on either side of the right angle, so that they make an angle of 45 degrees with the axis of the telescope. If now the one measuring surface A is not parallel to the other C, but makes an angle Ψ with C (position B), the angle Ψ is determined exactly as above by

measuring the distance of the reflected mark images of the two surfaces B and C.

It is required for this purpose, that the angle of the prism is exactly 90 degrees and that the legs of the triangle on the either side of the right angle make an angle of 45 degrees with the axis. Any deviations from this would enter into the result in quadruplicate, respectively the double amount.

In order to avoid this error, the zero setting of the micrometer is determined empirically. This is accomplished by using as the test piece a very good snap gauge (as one for example made from an end measuring rod and two jaws forced against it), which one sets up perpendicular to the plane of the drawing. In order to avoid its non-parallelism, the observation is repeated after turning the snap gauge 180 degrees. With a measurement the two positions gave readings of 15.48 and 13.54 T from which the actual zero point was calculated as 14.51. Simultaneously from this the non-parallelism of the vernier caliper was $\pm$ 0.97 T, which for 15 mm. wide measuring surfaces amounts to $\pm$ 0.18 u. (Direct measurements gave a very good check with this value of $\pm$ 0.12u).

A still more accurate determination results, if one forces against the gauge block E (Fig. 7) two good plane small gauge blocks once in the position a and then in the position b and sets it in these two combinations over the prism P in Fig. 6. In this manner the zero point gave the results 14.37 and 14.39 from two different series of measurements. The individual values deviated less than 0.1 T from the total mean 14.4 (from all 3 series of measurements). The non-parallelism of this gauge block E followed from the observations as $\pm$ 0.36 T. Measurements according to the method given in the next section under c gave the values $\pm$ 0.42 and $\pm$ 0.25 T, therefore an average of $\pm$ 0.34 T, corresponding to $\pm$ 0.16 u on a 35 mm. length of measuring surface, while the interference measurement (next section under b) gave the value $\pm$ 0.13 u, which is a very good check.

In order to determine the nonparellelism in the direction perpendicular to the plane of the drawing, the piece tested must be brought in this direction, which presents certain difficulties with micrometers and snap gauges and cannot possibly be carried with measuring machines. For this, one would have to swing the prism and the telescope 90 degrees out of the plane of the drawing, which would require a complicated construction. These difficulties can be avoided, if one sets up the prism according to Fig. 8 on its hypotenuse surface and above it sets a mirror at 45 degrees, as well as to turn the telescope 90 degrees about its axis. The leveling of the mirror is accomplished, in that the prism is replaced by a gauge block lying horizontal and the image reflected from it falls in the zero setting of the occular micrometer.

c. *Determination of the Parallelism of Measuring Surfaces Turned Away from One Another.* (Gauge blocks.)

a. Measurement of the Difference with the Amplifying Gauge. With small gauge blocks one determines the non-parallelism by measuring the length of the gauge block at various places, in that one passes it underneath an amplifying gauge (which is best supplied with two spherically shaped fingers); the accuracy rarely exceeds $\pm$ 0.1 *u*. This method fails with long gauge blocks, as they can not be held securely. Large gauge blocks with cylindrical cross-section are best laid in a prism inclined 45 degrees to the vertical on an excentrically arranged measuring finger, while that of the amplifying gauge is placed in the center point of the other measuring surface, and observes the deflection of the amplifying gauge when turning the gauge block.

b. Interference. The most exact determination of the parallelism results here also from the simultaneous observation of the interference bands of equal thickness between a plane glass plate and the upper measuring surface of the gauge block on the one hand and those between the same plane plate and a level plate forced against the lower measuring surface. One counts the visible dark interference bands within the length of a gauge block edge on the level plate and on the upper measuring surface. From the difference p of the two, the non-parallelism is determined as $\pm$ $\frac{1}{2}$ p $\lambda/2$ (λ is the wave length of the monochromatic light used) and using the light of the green helium line ($\lambda = 0.501$ *u*) is $\pm$ p 0.125 *u*. In order to obtain the non-parallelism in both directions, the observation is carried out with the position of the interference bands perpendicular to the long and perpendicular to the short edge of the gauge block. This method can be used with helium light for gauge blocks up to 25 mm. in length, with krypton light for those up to 100 mm. If one uses an interference apparatus built according to Michelson's principle, for example Koster's interferometer, one can measure lengths of twice this size, therefore under favorable conditions, gauge blocks of 200 mm. length.

c. Auto-Collimating Telescope. For large rectangular gauge blocks it is again best to use the method of the auto-collimating telescope. One sets up two auto-collimating telescopes the required distance apart (which on account of the parallel path of the rays in the object space can be as large as possible) so that their axes line up, so that the image of the mark of the one telescope always falls on the zero position of the ocular micrometer of the other telescope. The deviation of each measuring surface of the gauge block E set between (Fig. 9) from the vertical to the telescope axis is determined as above.

One can also get along with only one auto-collimating telescope according to Fig. 10 if one forces against the back measuring surface of the tested piece E a small plane gauge block a and the distance of the mark images reflected from E and from a is measured by means of the ocular micrometer. Therewith the gauge block a must be chosen so that its weight does not occasion an additional bending which must be considered.

The non-parallelism in the direction perpendicular to the plane of the drawing is obtained the simplest by turning the telescope 90 degrees.

D. Determination of Angles by Means of the Auto-Collimating Telescope. The determination of parallelism by means of the auto-collimating telescope is basically the measurement of an angle very closely approaching 180 or 0 degrees. So that this method is also very suitable for the measurement of other angles, as this is carried out in physical laboratories by means of the reflexion gonimeter. The very exact and therefore very expensive divided circle required by this can be dispensed with, if one has available an exactly measured normal angle of the required size.

To measure 90 degree angles (which are extensively used as steel angles in practice) one sets up 2 auto-collimating telescopes approximately 90 degrees to one another (Fig. 11, places the standard prism N between them and determines the position of the reflected mark images from its two surfaces by means of the two occular micrometers. The standard is then interchanged with the angle to be measured and the same procedure is followed. One determines in this manner the deviation of the tested piece in comparison to the standard angle.

One auto-collimating telescope would suffice if the piece tested and the standard are set above one another, so that their surfaces are approximately parallel, and turns them first so that the images of the marks reflected from their surfaces a and a′ (Fig. 12) fall into the telescope. After their distance has been measured with the occular micrometer, the piece tested and the standard (unchanged in their relative positions) are turned so that now b and b′ act as the reflecting surfaces and proceeds as before. One receives by this method again the difference of the angle of the piece tested and the standard.

With oft recurring measurements of angles of the same size one can also proceed in the following manner: the surface b of the piece tested is placed against a solid plane surface C and the deflection of the image from the zero point is determined. The zero point is obtained by first placing the standard with its surface b′ against the solid surface C, in which the deviation of the standard from its true value—exactly as with the above given methods—must be given consideration. The zero point is naturally checked at definite intervals.

Of course the pieces tested (respectively the solid surface C) should be adjusted, so that they are measured in the main section (that is in a plane perpendicular to the vertex line.

The methods given naturally can only be used for angles with polished surfaces, but give very accurate values, so that the errors with good plane surfaces only amount to ¼ to ½ second. To the steel angles determined in this manner can then be added those used in practice in another way.

The above remarks should above all show how the auto-collimating telescope can be used to advantage in the measuring science for the exact determination of non-parallelism and angles.—

X-Rays In Industry

Herbert R. Isenburger, New York, N. Y.

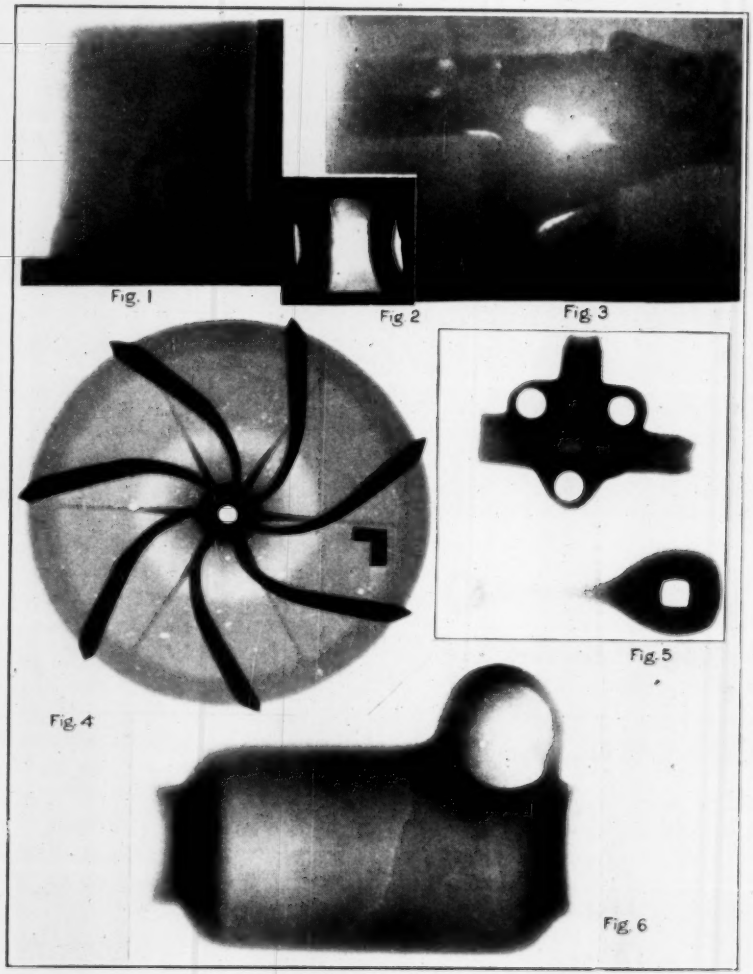
THE interest in X-ray examination is increasing as it permits non-destructive tests of materials. There are three methods of investigation, based on the three qualities characteristic of the short electro-magnetic waves: their penetrating power, their selective absorption of certain wave-lengths different for each element, and their diffraction in crystals.

Below I will discuss only the first of these in reference to the examination of rough or semi-finished metals. The inspection of the rough structure of metals by means of X-rays serves to discover slags, shrinkage, blow holes and the like in rough, semi-finished and finished products.

Inasmuch as the penetrating power decreases quickly with increasing atomic weight of the material, even small inclusions and blow-holes can be easily recognized. The pieces under investigation are placed between the focus of an X-ray tube and a photographic plate or fluorescent screen respectively, where the focus of the tube produces a shadow picture of the piece being examined.

This enables us to investigate materials in all states of manufacture without destroying the piece or causing any physical or chemical change. The diminishing strength of the X-rays, while penetrating materials, limits the inspection. In routine examination satisfactory details are obtained in radiographic inspection of bronze up to 2 in. thick, iron and steel up to 3½ in. and aluminum up to 12 in.; for inspection on the fluoroscopic screen the limits are: for bronze about ½ in., iron and steel 1 in. and aluminum 4 in. The appearance of the defects is almost the same for the different materials and can be raised up to 0.3% precision in radiography and up to 4% in fluoroscopy; this means for the blow holes in the direction of the rays in percent of the entire thickness of the material in the same direction. Straight, smooth shapes are more suitable for investigation than complicated ones with different thicknesses, which require skilled technique.

It is very important to protect the photographic plate against scattered radiation. The time of exposure decreases with increasing voltage. The details are not obtained in the exograph with high voltage, but with lower voltage and somewhat longer exposure time. The table gives the practical exposure times for bronze, iron and steel, and aluminum. The tests were made with a duplitized film and two intensifying screens with a focus distance of 16 in. from the film. The last column shows the current in 1/1000 amperes multiplied by the exposure time in minutes.



Continuous Current Kilo-Voltage	Thickness of the Material Under Investigation			Exposure Time Milliamp. x min.
	Bronze	Iron & Steel	Aluminum	
95	3/8"	1"	6 1/4"	240
115	5/8"	1 1/8"	8 1/2"	200
130	7/8"	1 1/2"	9 1/2"	200
185	1 1/2"	2 3/8"	13"	160
230	2"	3 1/8"	15 1/2"	80

The following illustrations show the application and importance of this method of inspection:

1. Examination of cast ingots and bars before rolling or drawing to determine impurities and porosity. Fig. 1 shows a brass cast bar about 1 in. thick; there is slight porosity toward the edge. Surface variations have been fairly well suppressed by the use of a liquid absorber.

2. Examination of pipes or cables for shrinkage or cracks from overdrawing. In Fig. 2 the elbow of an iron pipe fitting is shown; considerable shrinkage (visible as lighter spots) can be recognized remarkably well.

3. Inspection of high pressure machine parts (cylinders, pistons, boiler plates, etc.) before assembly, or inspection of expensive steel castings before machining. An electric steel casting, immersed in a liquid absorber is exographed in Fig. 3; in addition to general porosity there are some cavities which are evidently gas pockets.

4. Examination of welded and soldered seams clearly indicate badly welded joints.

5. Fluoroscopic inspection of die castings. A slightly porous aluminum casting (vacuum cleaner fan) is shown in Fig. 4 (the L on the left side is for orientation only) whereas Fig. 5 shows zinc castings, white spots indicate air bubbles. Fig. 6 shows a brass fitting. A series of almost connected small cavities are seen in the center of the casting, these could not be seen on the surface.

A very excellent book on the subject is Pullin & Wiltshire "X-Rays—Past and Present."

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Forest-fires occur most frequently during certain conditions of temperature, humidity and wind. National, state and private organizations are cooperating in efforts to reduce the enormous losses due to fires, most of which are avoidable. The United States Weather Bureau is cooperating in this important work in various ways. Instruments are loaned to equip weather observing stations situated in the forests where rangers take regular observations, and forward the same to forecast centers. From the latter, warnings of dangerous fire conditions are issued when necessary. Weather stations intended for forest-fire service are equipped with an instrument-shelter, thermometers, sling psychrometer, and a rain gauge; many of them also have anemometers, and a few have thermo-hydrographs.—Tycos-Rochester.

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A Device for Measuring the Brittleness of Rubber and Gutta Percha Compounds

*By G. T. Kohman and R L. Peek, Jr., New York, N. Y.**

A FAVORITE fancy of popular writers upon scientific subjects is a world in which the prevailing temperature range differs materially from that obtaining on the earth, and in which, therefore, substances would normally display properties very different from those that we associate with them. In the laboratory we are familiar with the property changes wrought by temperature, but it always remains a little difficult to think of mercury as a solid, for example, or of glass as a soft plastic substance. One material that undergoes extraordinary changes when the temperature is altered to a comparatively slight extent is rubber. The same is true of such related substances as gutta percha and balata.

It is generally known that these materials soften when heated: the change is most conspicuous in gutta percha, which is hard and firm at ordinary temperatures but becomes soft and plastic above 140° F. (60° C.). It is not so generally known that these materials harden so much on cooling that at very low temperatures they become as brittle as glass. Yet raw rubber, which is soft, flexible, and elastic at ordinary temperatures, if held in liquid air and then suddenly withdrawn and struck with a hammer, will fly into fragments. The same effect may be observed at any temperature up to —76° F. (—60° C.). A similar effect is shown by gutta percha compounds cooled below —22° F. (—30° C.).

When compounds of these substances are employed for insulating purposes it is necessary that they should not be brittle at temperatures at which the insulation may be employed, if it is likely in use to come under any strain. The insulation of a submarine cable, for example, must not be brittle at sea-bottom temperature, which is as low as 0° C. (32° F.) over large areas. In the study of materials intended for such purposes it is necessary to have available a practical test by which to determine whether the material is brittle or not.

The development of such a test involves certain difficulties, due to the fact that brittleness can only be arbitrarily defined. A material is said to be brittle when it fractures under a moderate deformation quickly applied, but in any test the degree of deformation and the rate of application must be arbitrarily chosen. The more severe test will employ greater deformation more rapidly employed.

*Bell Telephone Research Laboratories, Inc.

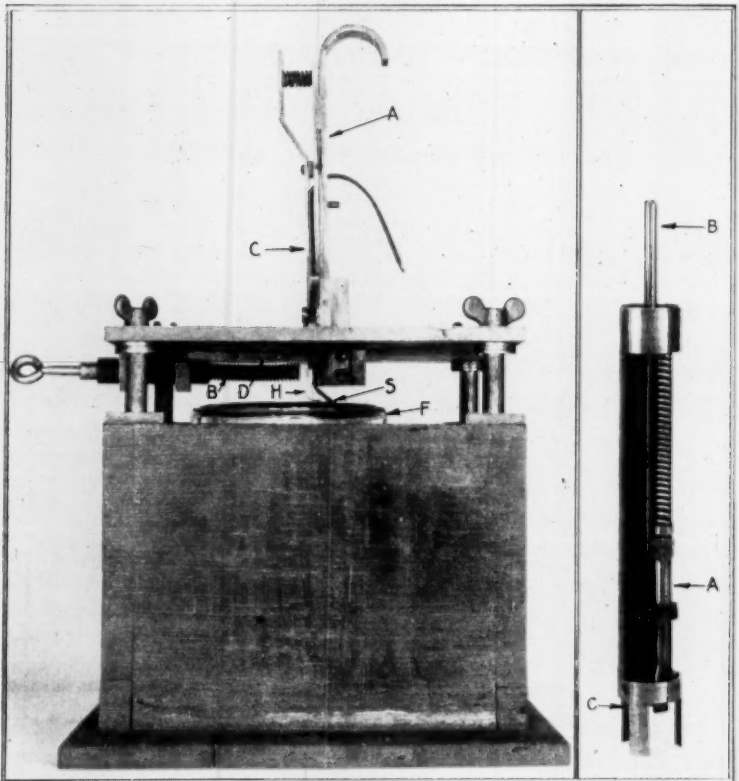

FIG. 1 FIG. 2

In a test developed by the authors the bending of a strip is used, and the highest temperature at which the strip will fracture under fixed conditions determined. The dependence of this temperature on the sample dimensions and on the rate and character of the deformation will be discussed below. The other factor in the design is that of temperature control and measurement. To provide for these, and at the same time to avoid having the mechanism subject to the varying resistance of the viscous bath liquid, the sample is held on a sliding vertical support, which normally holds the sample in the temperature bath. To test, this support is raised sharply and, as it brings the sample from the bath, automatically trips a hammer which bends the sample through a fixed angle (about 45 degrees).

Apparatus

A photograph of the apparatus is shown in Fig. 1. S is the sample held against the movable support A by the clamp C. The hammer H, operated by the spring B, is shown in the tripped position, in which it has bent the sample as shown. When the hammer is locked by means

of the catch D, the sample and support can be lowered into the Dewar flask F, in which is a temperature bath of ethyl alcohol. The temperature is adjusted by means of a small heating coil (not shown) and by additions of liquid air. The bath is stirred mechanically by a glass stirrer (dismounted, to simplify the photograph).

To measure the temperature a copper-constantan thermo-couple is employed, the e.m.f. generated due to the temperature difference between its junctions being read on a potentiometer. To avoid the inconvenience of having this e.m.f. change in sign when measuring temperatures above and below 32° F. (0° C.), the fixed junction is held in the steam over a bath of boiling water. All temperatures to be measured being well below 212° F. (100° C.), the e.m.f developed is always of the same sign.

Determination of Brittleness Temperature

The sample in the form of a strip approximately 0.050 inch (1.3 mm.) and 0.3 inch (7.6 mm.) wide is inserted beneath the clamp C in such a way as to project beyond the end of the support A far enough to be struck by the toe of the hammer when the latter is tripped. The support is then lowered into the bath and held there for about 2 minutes to allow the sample to reach the bath temperature. The support A is then sharply raised, tripping the hammer, and the sample examined for signs of fracture. If the sample breaks the operation is repeated at a higher temperature, if it does not break, at a lower; and this is repeated until the highest temperature at which the sample will fracture has been located, as can generally be done, within 2° C. The determination first made is checked by repeating the procedure, starting with a temperature slightly higher than the brittle temperature found in the first determination, and changing the temperature in the opposite direction.

For purposes of comparison, typical results are given in the accompanying table:

Brittleness Temperature of Rubber and Gutta Percha Compounds

	°C
Raw rubber:	
Pale crepe	−58
Smoked sheet	−57
Pure rubber hydrocarbon	−55
Pahang gutta percha	−28
Vulcanized rubber	−53
Balata	−44

Precise descriptions of the stocks listed are not included as the results given in the table are fairly typical. Compounded materials are generally brittle at higher temperatures, and for these the change is often not so sharp as for the materials listed.

As the test dimensions are arbitrary, the practical significance of the test would be somewhat uncertain if the brittle temperature were very sensitive to changes in these dimensions. Fortunately, however, this is not the case. Determinations were made on gutta percha samples using the hammer shown, which bends the sample through an angle of about 45 degrees, and with two other hammers of similar shape which bend the sample through angles of 15 and of nearly 90 degrees, respectively. The brittle temperatures determined with the three hammers were the same within 2°C., which is about the limit of reproducibility in any case. Tests were made on samples of gutta percha both 50 and 70 mils thick, and the results from the latter were from 5° to 10° C. higher than those from the former, indicating a comparatively slight difference in brittle temperature corresponding to the considerable increase in strain intensity involved in bending the thicker sample through the same angle. A similar test on samples of a rubber insulating compound indicated that its brittle temperature was the same for samples of these two thicknesses (50 and 70 mils).

When the spring tension used is light, the results are not so reproducible as when it is heavy. In the first case a stiff sample will be deformed more slowly than a soft one, and the test does not then afford a good comparison. Accordingly, the spring tension is maintained at a high value, so that the resistance of the sample is small compared with the frictional and inertia resistance of the hammer and the spring. The rate of movement of the hammer is thus very high, and nearly independent of the material tested. Under these conditions highly reproducible results are obtained. The spring actually used is under a tension of 12 pounds when held by the catch, and under a tension of 6 pounds when the hammer is resting against the sample holder. These approximate figures were obtained with a spring balance.

As from these data it follows that the brittle temperature is nearly independent of the test dimensions, this temperature may be safely taken as the minimum temperature for the safe use of the material. The deformation applied in the test being so severe, it is possible that the material might be safely used at this or at slightly lower temperatures, but the test gives positive evidence that if the temperature of use is above the brittle temperature there will be no danger of failure due to brittleness.

Apparatus for Material Under High Hydrostatic Pressure

A modified form of the apparatus, shown in Fig. 2, has been employed to determine brittle temperatures under high pressure. The sample, as a short strip, is held in a horizontal position below the lower plate, C, and is bent through an angle of about 60 degrees by the plunger A, which is shown in the released position. This apparatus is

placed in a high-pressure bomb, in which pressures up to 20,000 pounds per square inch can be generated by screwing down on a piston. When the bomb has been brought to the required temperature and pressure, the hammer plunger is released by the action of a screw acting through the wall of the bomb on the smaller plunger, B, of which the upper part projects above the rest of the apparatus (Fig. 2). This smaller plunger is beveled at its upper bearing, and in being forced down presses a small spring hinge to one side; this hinge is forced from a horizontal groove in the hammer plunger, and thus releases the latter.

Temperatures may be measured in the refrigerator in which the bomb is held for about 12 hours before each test. The slowness of the operation, the difficulties of temperature control, and the uncertain effect of the viscous resistance of the compressed cooling liquid on the plunger action have made it difficult to obtain precise results. It was found, however, that the brittle temperature of gutta percha and similar compounds thus determined, even at pressures up to 18,000 pounds per square inch, showed a difference of only 2° to 3° C. from the results obtained in the other apparatus at atmospheric pressures.

Marks Change in Structure of Material

It is evident from the sharpness of the brittle temperature, and its independence of precise test dimensions, that it represents a temperature range in which the physical properties of the material change very abruptly. Such an abrupt transition frequently indicates a change of state quite similar to that of a solid into a liquid or of a liquid to a gas. Solids frequently exist in different states, changing from one to the other at a definite temperature, the physical properties of the two states being quite different. Thus iron at 1445° F. (785° C.) changes its crystal structure and loses most of its magnetic susceptibility. The brittle temperature may possibly represent a similar transition for rubber.

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A Proposed Automatic Spectrum Analyzer

Arthur Schroder, Pittsburgh, Pa.

IN reviewing the literature on gas analysis, there seems to be no record of an automatic apparatus for analyzing or identifying gases by means of spectrum analysis. The following apparatus is, therefore proposed.

As every substance emits its characteristic spectrum, and each spectrum has one or more characteristic bright lines, it is proposed to use these lines to actuate a photo-electric cell, which in turn can operate relays or other indicating or recording devices, and so give an automatic record of conditions obtained at the time of analysis.

While this apparatus is proposed essentially for gas analysis, there is no reason why it could not be used for the spectral analysis of any light emitted by liquids or solids, and so serve as a means for analyzing these materials.

Description of Apparatus

Any type of spectroscope can be used, but for the sake of simplicity, we are showing a simple spectroscope (S) using a beam of light coming through a very narrow slit (s) as the source of illumination. The light from (S) impinges upon the prism (P). Here it is broken up into its component parts, forming a spectrum characteristic of the material emitting or transmitting the light being analyzed.

As each spectrum has a characteristic line or lines, we can interpose between the prism (P) and the ocular (O), a diaphragm containing a variable width slit, which diaphragm can be moved across the longitudinal axis of the spectroscope so that the band or line can be seen through the slit. Where spectrums contain lines rather than bands, the operation of the diaphragm is exactly the same, only in this case the slit in the diaphragm is narrowed sufficiently to permit only a particular line of the spectrum to be seen.

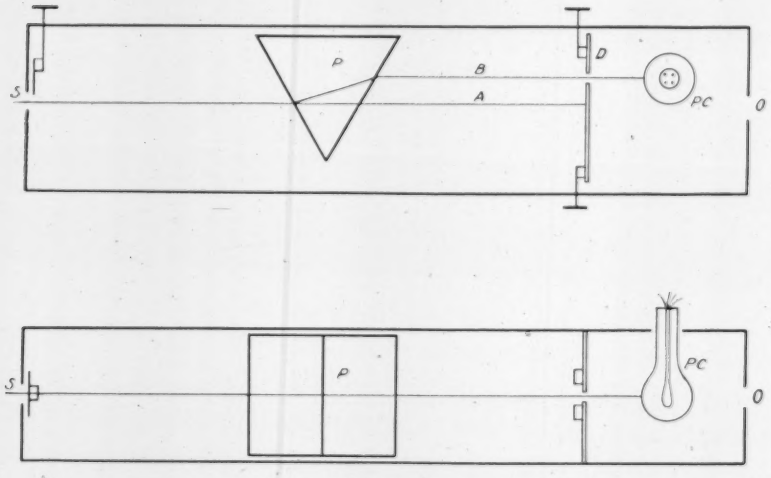
The light coming through this slit in the diaphragm then falls upon the element of a photo-electric cell, which is light-sensitive and is connected to a current indicating meter, or operates any other indicating, recording or operating apparatus through a system of relays.

In some cases, several slits in one diaphragm, or several superimposed diaphragms with slits at the proper locations, and several cells, might be used to indicate the presence of more than one gas.

Uses of Apparatus

The uses to which this apparatus could be put are practically limitless in number, but to indicate some of its uses, a few examples will be given.

In chemical reactions like the conversion of iron into steel in a Bessemer furnace, there is a marked change in the type of gases evolved during the reaction. During the preliminary burning-out period, carbon monoxide is by far the major constituent of the gas. Carbon dioxide is then formed just as the blow is completed. In actual practice, this change is fairly definite and serves as an end-point in the reaction.



LEGEND

A—Refracted ray stopped by diaphragm
B—Refracted ray passing through slit in diaphragm
D—Adjustable slit diaphragm
P—Prism, Grating, etc.
P.C.—Photo electric cell
O—Observation ocular for viewing line previous to setting P.C. in place.

This spectrum analyer can be used to control the Bessemer by setting the slit of the diaphragm so as to permit a characteristic line of the CO_2 spectrum to fall on the photo-electric cell. During the early part of the blow characteristic lines of the carbon monoxide spectrum while present, would fall upon the surface of the diaphragm and so be absorbed. However, when carbon dioxide is formed, one of its characteristic lines coincides with the slit in the diaphragm, is transmitted through it and actuates the photo-electric cell. This in turn operates an indicating lamp, sounds a bell, or does whatever else might be desired, all accomplished through such relays, resistances, etc., as might be necessary.

Another use of this apparatus might be found in the analysis of liquids. A strong beam of light of the proper characteristics could be transmitted through a liquid and the photo-electric cell operated when the light falling upon the slit in a predetermined position is characteristic of a particular substance sought after in the solution.

In some gases it might be found that the characteristic lines of two or more substances under observation might come rather close in the spectrum, and so interfere with the operation of the apparatus. It is quite possible that this could be eliminated by interposing in the path of the light, a color screen of a definite wavelength of light transmission. This screen would transmit one line or band and not transmit the other.

Many other applications can be conceived. It is merely proposed here to offer a suggestion as a possible means of eliminating the personal error in spectrum analyses and investigations.

Manuscript received March 13th, 1928.

TO SERVE USERS OF INSTRUMENTS

Instruments are universally used. They enter into innumerable operations. They are used in the most varied industries. They are today potent influences in aiding the manufacturer to carry out his operations at best efficiency and with great economy. They insure the production of the highest quality of product. They are real handmaidens of industry and they prove good investments, provided that they are properly selected and properly used.

The sole purpose of this publication is to disseminate practical information regarding the best selection and use of instruments for specific purposes. This information is gleaned from actual experience gained in the use of instruments and is not based on purely theoretical deductions. It is hoped that the availability of such knowledge through the columns of this publication will serve to foster the correct use of instruments, will aid the manufacturer in selecting the correct instrument for his purpose and will show him how others have been able to improve efficiency and economy in their operations through the aid of a good instrument, the never failing friend and associate of industry. —Instrument Investment News.

The above very excellently expresses the aim of INSTRUMENTS. It at the same time shows that there is a very definite demand for information of this kind. Since the appearance of INSTRUMENTS in January, three publications have appeared confining the information contained in their columns to instruments. The Fischer Scientific Company published the first issue of their LABORATORY in February. The INSTRUMENT INVESTMENT NEWS, published by the American Schaeffer & Budenberg Corpn., appeared in May and in the same month THE INSTRUMENT WORLD (published in England) made its appearance.

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It is hoped that all who are interested in the use of instruments will assist the periodical to achieve its purpose by contributing original papers, notes, etc., dealing with the particular subjects which engage their attention. Authors alone are responsible for statements made and opinions expressed in their respective articles.

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INSTRUMENTS PUBLISHING CO.

Eliminating Error With Spherical Points On Straingauge Levers

*P. J. McCullough, St. Louis, Mo.**

IT is not possible to eliminate all error in the results of any kind of a test, but sometimes it is possible to materially reduce the amount of error.

In Fig. 1 is shown two strain gauges alike in every way except as to the shape of the points. Gauge A has the conventional type of point shaped like a punch or cone, while the lever points of gauge B have been ground off and replaced with steel balls three thirty-seconds of an inch in diameter secured by fusion to the truncated cone so that the center of the ball is where the tip of the point was before grinding.

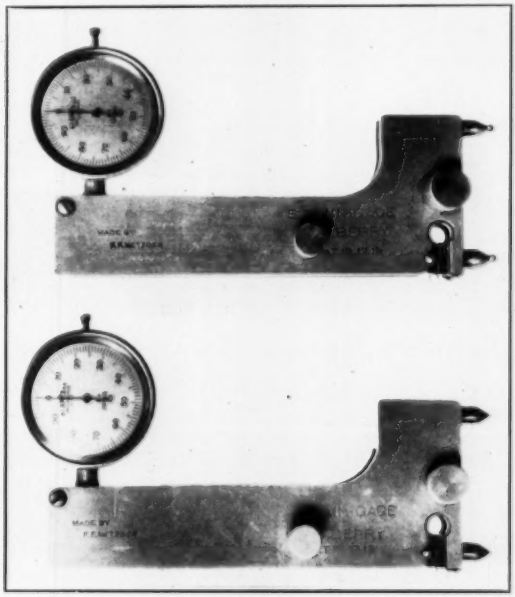


Fig. 1

The sharp cone point or the chisel point is all that is to be desired provided the surface of the test piece is not too rough, but when applied to an unfinished casting it is necessary to either punch or drill holes to secure the points a fixed distance apart. The punching or drilling also applies to pieces with smooth surface if vibration occurs as in fatigue testing.

In calibrating the strain gauge in question the distance from the center

*Engineer, Scullin Steel Company.

of the trunnion to the tip of the point is taken as the length of the short end of the lever. Therefore it is evident that if the point be inserted in a hole this end of the lever would in effect be shortened an amount equal to the distance from the tip of the point up to a line on a level with the point where contact is made with the rim of the hole, the diameter of which determines the amount of error.

If in place of the sharp points we substitute the spherical point and place it in the same hole the turning point will always be at the center of the sphere regardless of the shape or size of the hole (within reasonable limits), so that no error due to change in effective leverage enters into the results of a straight tension or compression test.

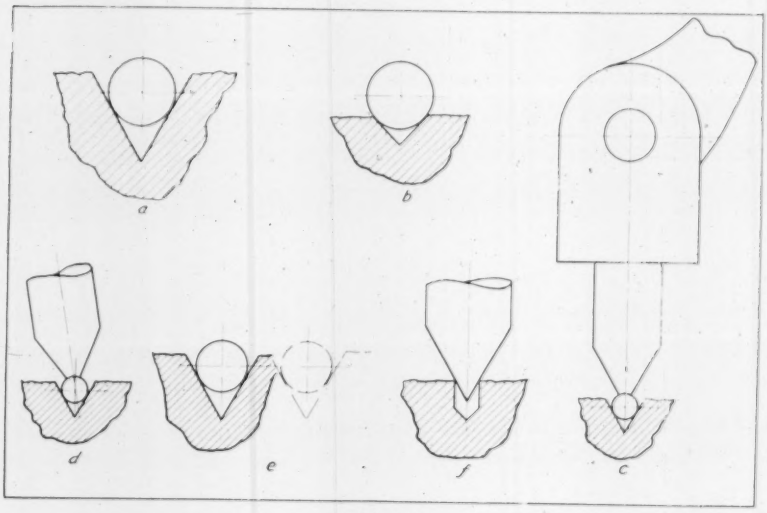


Fig. 2.

Fig. 2 (a), (b), (c), (d) and (e) are figures showing how the spherical point operates without changing the effective length of a caliper gauge lever regardless of shape or angle of the punch mark.

(f) indicates that when a cone point is inserted in a hole and operated as a lever there will be a sweeping movement of the point making an arc the chord length of which represents the amount of error, provided the extreme tip of the cone is one end of the lever.

Hard sandy surface or scale on an unfinished casting will soon dull the point of any punch so that a reliable contact cannot be made with the punch point type of lever making it necessary to drill holes for contact.

———— :: ————

Sharp competition necessitates the elimination of all unnecessary waste. Burning less fuel, wasting less power and saving labor are just as important as making more sales and shipping more goods.

In all industries there are operations and processes in which instruments are of great value in maintaining the correct conditions.

New Instruments

Recently Developed by Instrument Manufacturers

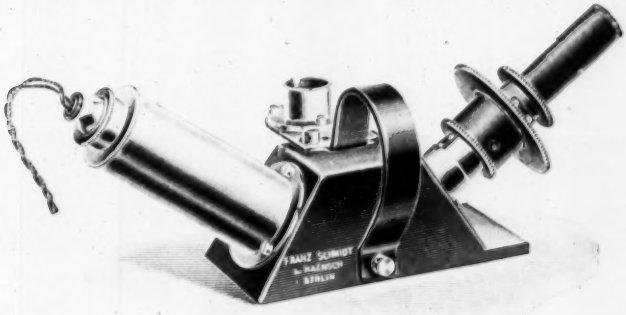
Kiser Polarization Luster Meter, and Blackness Meter for Paper

(Akatos, Inc.)

THIS instrument serves for measuring the lustre (or gloss) of white paper, as well as the blackness of paper.

1. FOR WHITE PAPER—The light reflected from the surface of the paper is partly rectilinear polarized, the amount of which is in close relation to the lustre of paper and can therefore be accepted as a measure of the lustre.

The Polarization Luster Meter consists of an illumination device, the light of which falls on the surface of the paper and a polarization pho-



tometer (Martens type), which allows in a perfect and very simple form the measurement of that portion of the light which is polarized by the surface of the paper.

The illumination body, the base of which is covered with cloth, is placed on the paper under examination. The paper must be absolutely smooth and flat below the rectangular aperture of the base of the instrument. The lamp of the illumination device must be connected with a 4 volt current. In itself the measurement is independent of the strength or uniformity of illumination from the light source, which is a great advantage compared with other photometric measuring methods. However, it is advisable to regulate the illumination by means of a resistance of several ohms, so that a suitable degree of brightness for all observations is obtained. The polarizing device is inserted into the lateral sleeve tube in such manner that a small pointer fits into the notch of the sleeve tube.

The measurement should be made in a semi-dark room. By looking through the eye-piece, a two part field of image will be seen, of which one-half will be bright and the other dark. By turning the eye-piece part, it is possible to match the two halves to uniform brightness over the entire field. In this position the degree of gloss is read by means of an index from the inner scale of the divided circle. The gloss degree scale shows four times the same numbers. For quick observation it is sufficient to measure within one range of the field, in order to obtain approximate accuracy of the measurement. For absolute accurate requirements, however, it is necessary to make three readings in each of the four ranges and to take the average of the reading results.

2. THE USE OF THE INSTRUMENT AS A METER FOR MEASURING THE BLACKNESS OF PAPER—If the cap with one central aperture on the polarization photometer head is interchanged with the one of two lateral apertures, it can be used for measuring the degree of blackness.

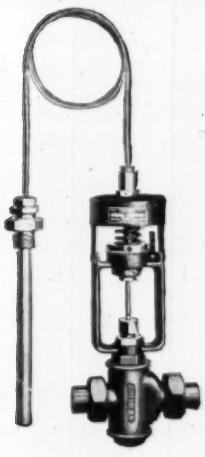
For this purpose it is inserted into the vertical sleeve tube, situated opposite the handle. Below the sleeve tube is a pointer, and a few millimeter distance from this pointer the two objects are placed for examination. The blackened paper must be compared with a white paper of the same kind. For instance, if it is desired to measure the graduation curve of photographic paper, a sensitometer scale (in the Scheiner sensitometer or Eder-Hecht sensitometer) must be made. Simultaneously an equally large strip is fixed and washed. Both strips are then put together in such way that one fine line divides the two. The pointer should be on the dividing line of the two papers. Then the divided circle is turned until uniform illumination of both image halves is obtained, and the angular degree is read from the outer scale on the circle.

With this instrument it is possible to estimate fractional readings between 2 degree lines and thereby enable the determination of very small differences in blackness between two papers. Comparisons are made with paper regarded as standard or with any normal paper known as pure white. Papers dull coated with barium oxide are especially suitable as normal comparison papers.

American Precision Controller

(American Schaeffer & Budenberg Corp.)

THIS new regulator has been designed to meet the growing demand for a Self-Contained Automatic Controller of robust simplicity, high sensitivity and low cost. By combining a very flexible bellows of entirely new design with an operating spring of exceptionally large diameter and great length, a mechanism has been secured which can be relied on to hold temperatures constant within very close limits. With favorable conditions, regulation can be secured within 1°F. consistently without need of manual attention.



The heart of any temperature controller of this kind is the bellows. The American Precision Temperature Controller uses the Cook bellows which is widely known in the oil burner industry in connection with the Cook pump. In the development of this pump, the Cook engineers used all the leading makes of bellows, including the so-called "one-piece" rolled type. They could not obtain a satisfactory life from any of these and, therefore, decided to make their own. Many tests had proved that it was very difficult to secure a satisfactory soldered joint for the two end plates used with "one-piece" bellows. Moreover, rolled bellows must necessarily be made from soft, tough metal and cannot have the temper or hardness desirable in any spring (hollow or otherwise).

To secure full advantage of the great flexibility of the Cook bellows which permits of maximum valve travel with minimum increase in the internal vapor pressure, it was necessary to provide a spring of equal flexibility. This result is obtained by the use of a long spring of large diameter and having a large number of coils. The valve spring is of steel, carefully tempered and Parkerized for long life. It is housed in the top of the controller, well removed from the heat.

The valve used with the American Controller is of the double seated, balanced type, designed specially for it and generously proportioned. It is built throughout in our own valve factory, with the same skill and care for which American safety and relief valves have been known for over 30 years. Made entirely of bronze, screwed inlet and outlet, furnished with unions. The stuffing box, through which the valve spindle passes, has been made unusually long to provide plenty of space for packing. To reduce friction to a minimum and still prevent leaking, the valve spindle is made of monel. The packing is held in place by a light

spring, guided by a bronze sleeve. Thus, very slight pressure secures a permanently tight stuffing box.

The bulb is inserted into the tank or other container in which the temperature is to be controlled. The valve is installed into a by-pass of the supply line furnishing steam or other heating medium to the tank. The bulb is partly filled with a volatile fluid which vaporizes at or near the temperature to be maintained. This creates a vapor pressure in the bulb which is conveyed to the bellows by the capillary connecting tubing. The bellows then expands, thus pushing the valve stem downwards against the tension of valve spring and closing valve.

Since the vapor pressure in the bulb will always be in exact proportion to the temperature in the container, the valve will assume a throttling position, admitting only sufficient heating medium to the apparatus to maintain the desired temperature. The setting point may be adjusted by turning the nut by means of a pin inserted in holes drilled in the rim of the nut. This varies the tension of valve spring and thus determines the pressure required to expand the bellows. A scale enables a given adjustment to be repeated accurately after it has been changed.

To guard against damage to the bellows from over-pressure caused by accidental overheating, a spring is placed between the upper and lower parts of the valve stem. Should the pressure in the bellows continue to rise after it has completed its stroke and the valve has seated, this spring will be compressed, thus allowing further expansion. The volatile fluid in the pressure system is so proportioned that all of the fluid in the bulb will be vaporized before the spring is completely compressed. This means that the greatest pressure which can be generated in the system, under any circumstance, will not damage it.

The great sensitiveness of the operating mechanism makes possible the use of a comparatively small bulb. The standard bulb is 10 inches long including thread by $\frac{5}{8}$ in. diameter and equipped with $\frac{3}{4}$ in. S.P.T. union connection. This is the minimum size. It is regularly made of copper. Bulbs of steel or monel can be furnished on special order. Also special bulbs for air or any other service. Bulbs can also be protected by separable sockets or sleeves when required.

STANDARD TEMPERATURE RANGES AVAILABLE

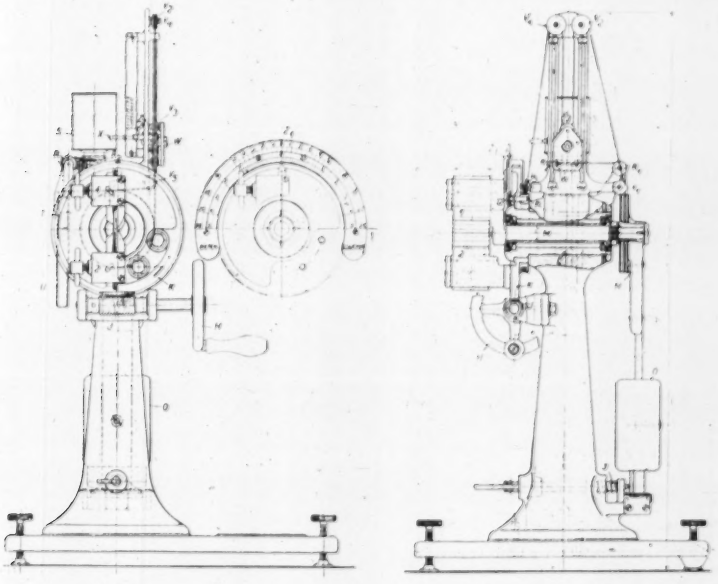
50— 95° F.	135—175° F.	210—245° F.	290—350° F.
90—135° F.	165—210° F.	225—270° F.	325—385° F.
110—150° F.	185—220° F.	260—325° F.	

The Precision Controller is practically suited for hot water service tanks, water heaters, retorts, cookers, and kettles, can washers, dye vats, dying machinery, size boxes, dry kilns, or wherever a simple controller is required for very close regulation.

New Instrument for Testing the Bending Strength and Bending Angle of Boards

(Foreign Paper Mills, Inc.)

THE board bending tester is shown in the diagram. The complete testing apparatus is contained in and fitted to a vertical column, the latter being fixed to a base plate which is horizontally adjustable by means of leveling screws. The bending strength test is brought about by turning the handwheel H, thus actuating the worm shaft and worm J, causing the worm wheel K to revolve as indicated by the arrow (counter-clockwise).



The wormwheel revolves on the bushing L carried in the column. Clamp 2 is screwed to the wormwheel and with the board gripped between the plates clamp 1 follows clamp 2. Clamp 1 ends in a shaft with a square head.

Fitted to the latter is a rope pulley N which carries an extension to which is screwed a guide rail for weight O. A cord is carried from the rope pulley N over guide pulleys R_1, R_2, R_3. R_3 is connected to a recording drum S so that on raising the weight O, pen X draws a horizontal line on the drum, indicating the amount of the load. Weight T, sliding in the pipe U insures the return motion of the drum with the downward movement of the weight O in its horizontal position.

From the rope pulley P which is fixed to wormwheel K, a cord is carried over guide pulleys V_1, V_2, V_4, V_5 and loose pulley V_3 to rope pulley N. Both rope pulleys have the same diameter, so that if clamping devices 1 and 2 were connected by perfectly rigid means, a length of cord would be reeled up on the rope pulley P exactly equal to the length of rope unwound from rope pulley N, when turning the wormwheel. In the above case, writing slide W connected to pulley V_3 would remain stationary. If, however, an elastic body is gripped in clamps 1 and 2, P turns through a larger angle than N; in other words—more rope is reeled up on P than unwound from N and loose pulley V_3 with writing slide attached moves upwards and records the angle by which clamp 1 is retarded in relation to clamp 2 i.e., the bending angle through which the material under test has been bent. Apart from the graphic records of load and bending angle, their values can be read off in any position by means of pointer Z_1 and Z_2 on their respective graduations. In order to prevent prolonged oscillation of the weight in the case of a break, when making bending tests with brittle boards, which would result in an indistinct and repeatedly overwritten diagram, a device is provided which by means of a spring pin Y arrests the weight in its lowest position.

The fixed position of worm J between the two bearings excludes any involuntary influence on the bending results. The strength being measured on the place where the bending takes place, without the assistance of intermediate transmitting members, correct bending results are insured.

Shaft M runs in ball bearings so that the power taken up by friction of the bearings is exceedingly small. The friction between worm and wormwheel, wormwheel shaft and bearing does not affect the measuring operation.

The calibration of the bending tester is effected in a very simple manner. A thin steel band is fixed to pulley N with the radius r. It is carried over a fixed pulley and loaded with P grams so that the amplitude of the weight O can be determined for a certain load. P x r represents the value of the external bending moment. The bending tester is provided with two loading weights.

Practical Application of the Bending Tester

Control of the manufacturing process.

Determination of the influence of the thickness of layers as well as of the press load, on bending strength and bending angle of boards.

Obtaining comparative data concerning the different methods of grinding, coarseness of stones, natural or artificial stones, etc.

Testing the influence of steam pressure and period of steaming.

The apparatus is of considerable service to fibre mills for analyzing influences due to loading materials and sizing.

Check on the qualities of raw materials used in the card board and folding box industries.

Determining the smallest break bending angle which is important to know when working boards.

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"Concentration is the secret of strength."—Emerson.

Universal Service Set Tester Model 500

(Hoyt Electrical Instrument Works)

THE Hoyt Universal Service Set Tester is a compact, accurate instrument for making rapid tests of wiring, power supply and tubes, in all kinds of radio receiving sets, without disturbing connections or accessories. Tubes may be tested with this instrument under actual working conditions and A.C. line voltage of "electric sets" checked as well. Tests of voltage and current delivered by eliminators or power amplifiers can be readily determined and rectifier tubes checked.

The tester is equipped with a D.C. precision moving coil volt-milliammeter and a three-range A.C. voltmeter. The D.C. voltmeter has a

resistance of 1000 ohms per volt. A long scale, knife edge pointer and excellent damping make close and rapid readings possible. Five D.C. scales are furnished—10 volts, 100 volts, 500 volts, 25 milliamps and 100 milliamps. Three scales are available on the A.C. voltmeter—3 volts and 9 volts for tube filament voltage measurements and 150 volts for checking the A.C. line voltage.

The instrument contains a tube socket and has a flexible four-wire lead terminating in a plug which, with the furnished adaptors, fits all receiving set tube sockets. Plainly marked push-buttons and switches provide easy operation during each test. The instrument is housed in a handsome mahogany case equipped with carrying handle and rubber feet; the cover is removable on slip hinges for convenience in use.

New Calculator Now Sold in United States

A CALCULATOR which was introduced from England a year ago is now being sold exclusively in the United States by the A. S. Aloe Co. This is the Otis King's Calculator, an instrument which in pocket size (6 in. when closed) provides, it is said, the calculating facilities of an ordinary slide rule 66 in. long, with a correspondingly high degree of accuracy. Accurate results to four or five significant figures can be relied upon, it is asserted by the company mentioned. Its use is easily learned, owing to its simplicity.

The calculator consists of two metal tubes, the smaller (cylinder) being free to rotate and slide within the larger (holder). Spiral scales are mounted on each of these tubes, and a third tube mounted on the holder forms a tubular cursor, or indicator, carrying at each end an engraved arrow, which can be set to any mark, or to which any mark can be set. The three parts of the instrument are inseparable, and being made of metal throughout there is no possibility of their warping, or being affected in any other way by climatic conditions.

The calculator is made in two models known as Model "K" for general work and ordinary calculations, and Model "L" with a logarithmetic scale, especially adapted for electrical and chemical formulae, etc. The scales are printed on a special celluloid material with the printing on the underneath side of the transparent celluloid. The calculator has met with approval of the leading engineers, universities and chemists throughout the United States.

The size of the instrument, fully extended, is 10 in. by 1⅛ in. closed 6 in. by 1⅛ in.

Sugar Ash Bridge

(Leeds & Northrup Company)

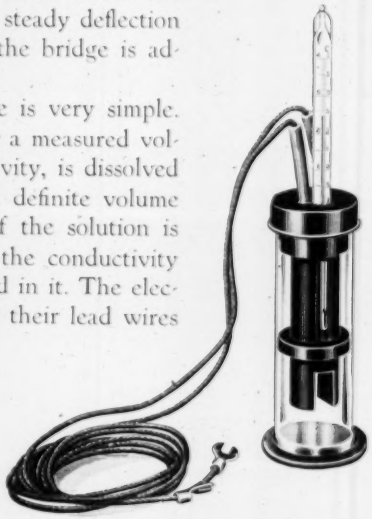
The electrical method for ash determination is based on the fact that a sugar solution containing ash constituents will conduct electricity, and that the current flowing between two fixed electrodes in the solution varies with the quantity of ash constituents present. The conductivity of the solution—and hence its total soluble ash—can be measured very easily. Various sugar chemists have repeatedly shown that such measurements are several times as accurate as the most carefully-done chemical determinations. Duplicate electrical determinations will agree far more closely than duplicate chemical determinations.

A principal point of interest in this equipment is that it uses current at commercial frequencies, with a galvanometer to detect balance. In the type of bridge commonly employed, the current is at audio frequency. It is not practicable to build an a.c. galvanometer sufficiently sensitive for audio ranges, and the detector is therefore a telephone. The balance is indicated by silence or a minimum of sound in the receiver, and such an equipment must be set up in a quiet room because the least noise will disturb the user.

This requirement is entirely overcome by the use of current at commercial frequencies, with a galvanometer as the balance indicator. Though there is a possibility of some polarization at the lower frequencies, it has been demonstrated that such an effect does not cause an error of any significance within the limits of accuracy required. Conductivity measurements with an audio frequency bridge can be duplicated with the low frequency bridge to within 0.1 or 0.2 per cent.

A highly efficient type of alternating current galvanometer is incorporated in the sugar ash bridge. The magnet comprises a laminated transformer steel arc with a winding for 110 volts. Alternating current in the winding produces an alternating field between the poles. The galvanometer moving coil is suspended in this field, with its terminals extended to the bridge circuit. Current for the bridge circuit is obtained

through taps from the terminals of a resistance in series with the magnet winding. By this arrangement the alternating potential differences at the terminals of the moving coil due to an unbalanced condition of the bridge must be always in synchronism with the alternating magnetic field; hence a steady deflection occurs, which approaches zero as the bridge is adjusted for balance.



The method of using the bridge is very simple. A weighed sample of substance, or a measured volume of juice of known specific gravity, is dissolved in distilled water and diluted to a definite volume in a measuring flask. A portion of the solution is poured into the glass cylinder of the conductivity cell and the electrodes are immersed in it. The electrodes of the cell are connected by their lead wires to binding posts on the bridge and the bridge is connected to an alternating current circuit of 110 volts, and 60 cycles or lower frequency.

The conductivity of the solution is determined by pressing a button on the top plate of the bridge and rotating a knob until the deflection of the galvanometer on the bridge is zero, which indicates that the bridge is balanced. When the bridge has been balanced, the reading of the scale on the slide wire actuated by the knob is multiplied by 1, 10, 100, 1000, or 10,000, according to the position at which a plug on the top plate was set when the measurement was made, this shows specific conductance (i.e., the conductivity) of the solution directly.

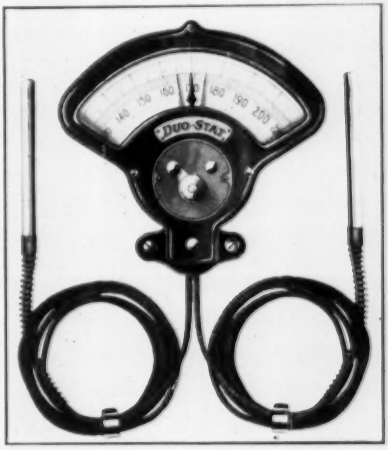
The ash content can then be found from a table showing the relation of conductivity to ash content, or by multiplying the measured conductivity by a factor expressing such relationship.

The accuracy of sugar ash determinations with this instrument is very largely due to the fact that the reading is made in conductivity and not in percent ash direct. The instrument is calibrated in this way because the relationship between conductivity and the percent of soluble ash is not necessarily the same for beet sugar from different regions or cane sugar from different provinces. Each chemist, on receipt of the bridge, saves a small portion of each sample on which he runs a chemical ash determination and measures its conductivity. He keeps a data sheet showing both the percent of ash and the conductivity of each sample. When he has accumulated data for 40 or 50 samples which vary appreciably in ash, he prepares a curve or table showing the relationship between the conductivity and the ash. The use of this table insures an extremely high degree of accuracy.

The Raymond Duo Stat

(F. I. Raymond Company)

THE Duo-Stat is a standard pattern of the well known distance type thermometer with high and low contacts, with the important exception that it has two bulbs instead of one. Both bulbs are connected to and act upon the same hollow coil spring which moves the needle between the contact points.



Fine capillary tubing covered with braided wire extends from each bulb to the hollow coil spring on which the needle is mounted. The bulbs, capillary tubing and coil spring are all completely filled with liquid which expands and contracts with changes in temperature. When the bulbs are heated, liquid is driven out through the capillary tubing into the hollow spring, causing it to unwind. When they are cooled, liquid is drawn back, and the hollow spring rewinds. When one bulb is cooled and the other is heated in a like degree, the liquid which is expelled by the heated bulb is drawn in by the cooled bulb and the needle does not move.

The needle thus indicates the sum of the temperatures of the two bulbs and it is upon this basis that the Duo-Stat operates as described.

This type of instrument with only one bulb has been used for years to indicate temperatures at a point removed from the source of the temperature. In construction and operation the Duo-Stat is identical with the thousands of one bulb instruments which have been produced and are giving unfailing service in army and navy airplanes, automobiles and all classes of industry.

THE OPERATION OF THE DUO-STAT—One bulb of the Duo-Stat is placed at any convenient location outdoors, the other is placed in the boiler or clamped onto the riser. When the outdoor bulb is cooled, the boiler bulb can be heated to a higher temperature before the needle reaches the high contact than it can when the outdoor bulb is warm. If the high contact needle is set at 170, and the outdoor bulb is zero, the boiler bulb can be heated at 170 before the fire is retarded. However, when the outdoor bulb is 60, the boiler bulb can only be heated at 110 before the fire is retarded.

THE OPERATION OF THE DUO-STAT IN A HOT WATER HEATING SYSTEM—The calibration of the Duo-Stat is based on the observation that, in the ordinary hot water heating system, the proper boiler limits are 170 in zero weather and 110 in 60 weather with proportional intermediate limits.

The Duo-Stat limits the boiler automatically in this fashion as described above, thus allowing enough heat at all times to heat the house easily at 70 in any kind of weather and at the same time preventing any possibility of building up an objectionable excess of heat in the radiators. The room temperature is easily raised to 70 after a depressed period. The home owner has a degree of control above 70 at the room thermostat.

An open window or door, while depressing the room thermostat, will cause only a slight excess of heat in the rest of the house and will build up no objectionable radiator temperatures. Likewise, abuses in the setting of the thermostat will cause no objectionable overheating.

The graduations on the Duo-Stat indicate the limit of boiler temperature when the outdoor bulb is at zero. Some systems may require 180 or even 190 while the others may require only 150 or 160. The Duo-Stat is set once at that temperature required at zero in the particular system on which it is used. From then on it performs its work automatically for all time. The Duo-Stat never needs to be reset and the system becomes 100% automatic.

POINT CONTROL OF ROOM TEMPERATURE—Besides eliminating overheating, the Raymond System of Heat Regulation, composed of the Duo-Stat and a room thermostat, actually accomplishes a new method of temperature control, in that it gives point control of room temperature without producing a condition of fluttering fire.

Heretofore every system of heat regulation has controlled the room temperature between a high and low limit. The fire came on at the lower limit and went off at the upper limit.

With the Raymond system, the room temperature is not regulated between limits, but above and below a point. The upper contact of the room thermostat could actually be removed without effecting the system during normal operation. The room thermostat turns the fire on but the Duo-Stat turns it off.

Advertise for the men your salesmen may never see, but the men who influence sales. Advertising goes through doors that are closed to your salesmen—and to your competitors' salesmen. Advertising does more than influence customers on whom your salesmen do not call. The repetition of your selling points impresses them on the minds of prospects. Men who have learned something of your company and your instruments from your advertising are easier men for your salesmen to see—they are easier men to sell. Your advertisement in INSTRUMENTS creates confidence and prestige.

The Whittemore Strain Gage*

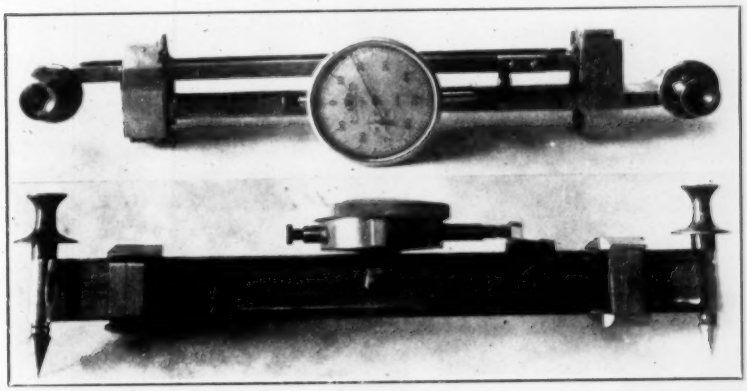
By H. L. Whittemore

THE design of steel and concrete structures was placed on a more secure basis when strain gages came into use to measure the stresses which known loads caused in the structure.**

The computed stresses at any place in a member could then be compared with the stresses found with the strain gage. This resulted in a better understanding of the behavior of the member by the designing engineer and the development of more satisfactory methods of designing.

This patented strain gage consists essentially of two parallel bars of Invar steel having a low coefficient of expansion for temperature changes.

The bars are connected transversely at the ends by flat steel springs which permit one bar to move longitudinally with respect to the other but prevents other movements.



At each end, the instrument is provided with conical points which are inserted into small holes in the member. A dial micrometer is attached to one of the bars. The spindle of this dial bears against a suitable projection on the other bar. Changes in the distance between the points is therefore indicated directly by the dial micrometer.

The principal advantages of this instrument over other strain gages are the following:—

The elimination of all bearings or sliding surfaces so that the frame of the instrument is not affected by dust, dirt or corrosion.

The points having an angle of 30 degrees seat more firmly in the holes in the member.

*Publication approved by the Director of the Bureau of Standards of the U. S. Dept. of Commerce.

**Use of the strain gage in Testing Materials, Slater & Moore, p. 1019, vol. XIII, 1913, Proceedings Am. Soc. Test. Mat.

Because the axes of the points are parallel at all times the diameters of the holes may vary greatly without causing appreciable errors in the readings. With the bell crank lever type of instrument having one point on the short arm of the bell crank, any differences in the diameters of the holes make a corresponding difference in the length of the short arm and therefore a difference in the reading.

The dial is so placed that it is more easily and more accurately read by the observer.

If the dial micrometer is damaged it may be replaced by another calibrated dial and the work continued without recalibrating the strain gage. In fact, the accuracy of this instrument is for practical purposes the accuracy of the dial micrometer.

When using other types of strain gauges some engineers read all the gage lines, perhaps thirty, then repeat until successive readings for each gage line are in sufficiently close agreement, say 0.0002 in. for a ten inch gage line. It may be necessary to repeat the reading three or four times. With this new instrument it has been found that two successive readings agree so closely that more are unnecessary and in some cases one would be sufficient.

This type of strain gage was devised by the author for the Committee on the Investigation of Arch Dams, of the Engineering Foundation. The instrument shown in the photograph was made by Col. W. S. Binckley, a member of the Committee who perfected the instrument and decreased the weight. His instrument weighed less than 1½ lbs. complete with dial.

Summing up, the advantages of the new strain gage are:

1. Simplicity of construction.
2. Freedom from disarrangement.
3. Freedom from error due to variation in the diameter of this gage holes.
4. Accuracy of reading.
5. Saving of time.

——— :: ———

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Catalogue Library

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Alternating Torsion Machine

The Lehmann & Michels, Hamburg-Altona, Germany, have a leaflet describing the Foeppl-Basemann Alternating Torsion Testing Machine. This leaflet is printed in German.

Altimeters

Literature on the Paulin System Altimeters is being distributed by the American Paulin System, Inc., 1220 Maple Ave., Los Angeles, Calif.

Automatic Burette

A leaflet describing and illustrating a new automatic burette with accurate zero setting has just been received from Robert Mueller, Essen, Germany. This information is printed in German.

Benzol Determination Apparatus

Three instruments for the determination of Benzol in raw and finished gas are described and illustrated in a bulletin of Robert Mueller, Essen, Germany. This literature is printed in German.

Binocular Microscope

Catalog D-115, 1-28, issued by the Bausch & Lomb Optical Co., Rochester, N. Y., describes and illustrates their Wide Field Binocular Microscope. This catalog lists the many uses and users of this instrument.

Brinell Microscope Projector

The "Busch-Schumann Projector" is the title of a leaflet issued by A. Schumann, Duesseldorf 70, Germany. This instrument projects an image of the Brinell ball impression and the mm. scale onto a ground glass screen. This information is printed in German.

The Carbic Light

is the title of a recent booklet issued by the Oxweld Acetylene Company, 30 East 42 St., New York, N. Y.

Condensation Meter

The Cadillac Condensation Meter is covered by Catalog No. 14 recently issued by the Central Station Steam Company, Detroit, Mich. This literature takes up the following items: General Description; Application; Types and Sizes; Principle of Operation; Special Features of Metering Drum; Accuracy; Case; Inlet Spout; Counter; Counter Housing; Bearings; Maintenance Features and Determining the Meter Size.

Counters

Bulletin No. 365 issued by The Bristol Company, Waterbury, Conn., describes Bristol's Counters. The Bulletin covers the following types of counters: Barrel Type Counters, Set Back Counters; Engine Counters and Magnetic Counters.

Frequency Indicator

Circ. 9851d-G-90-1127 briefly illustrates the new L & N Switchboard Frequency Indicator. This is issued by Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia, Pa.

Gas Service Journal

The Gas Service Journal published by the Pittsburgh Equitable Meter Company, 400 Lexington Ave., Pittsburgh, Pa., contained the following articles in the May issue: Building an Empire; and the Curb Meter as We Have Seen It.

Humidity Controller and Indicator

The "Aminco" Electric Humidity Controller and Indicator is briefly described in a new leaflet issued by the American Instrument Company, Inc., 1220 D Street, N.W., Washington, D. C.

Instrument Investment News

The American Schaeffer & Budenberg Company, 338 Berry St., Brooklyn, N. Y., have issued a new House Organ beginning May, 1928, having the above title. They state this publication is "devoted to the Dissemination of Practical Information on the Measurement and Control of Manufacturing Operations." Vol. 1, No. 1 contains the following articles: The Cocoa Butter Ingredient Determines the Utility of Cocoa. Both Time and Temperature Govern Dyeing Results. Chemical Forces Must be Controlled. Changing One Form of Steam Into Another.

Liquid Meters

The description of the mechanical construction of Bassler Liquid Meters is taken up in a recent leaflet of the American Liquid Meter Co., Alhambra, Calif.

Machine Tools

Catalog No. 5 issued by the Small Tool Division of the Lufkin Rull Co., Saginaw, Mich., describes and illustrates Lufkin tools.

Mecury Switches and Control Instruments

The Absolute Con-Tac-Tor Corporation, Elkhart, Indiana, have issued a folder with the above title. The following Bulletins are contained in the folder: 100 Mercury Switches, 111 Oil Burner Controls, 120 Refrigeration Controls, 130 Blower Controls, and 140 Unit Heater Controls.

Megohmer

The A. C. Nielsen Company has recently prepared the following surveys: SI-54-GM Model D Megohmer used in Office Building Circuit Testing; SI-52-GZ Sticht Ground Ohmer used by Union Switch & Signal Company; SI-55-GI 2 in 1 Megohmer used by A. M. Byers Company; SI-58-QM 2 in 1 Megohmer used by a large paper box manufacturer; and SI-56-GZ Applications of 2 in 1 Megohmer used by Rubel Coal & Ice Company. These surveys are being distributed by Herman H. Sticht Co., 21 Park Row, New York, N. Y.

Microscopes in Metallurgy

"Microscopes in Metallurgy" is the title of bulletin E-213-V-28 recently issued by the Bausch & Lomb Optical Company, Rochester, N. Y.

Microphotometer
Bulletin MF 25 issued by P. J. Kipp & Zonen, Delft, Holland, describes and illustrates Moll's Recording Microphotometer. This bulletin is printed in English.

Mine Gas Apparatus
The Schondorff-Broockmann Mine Gas Apparatus is described in a leaflet of Robert Mueller, Essen, Germany. This literature is printed in German.

Photomicrographic Camera
A Record Making Photomicrographic Camera is taken up in Bulletin E-212, III-28 issued by the Bausch & Lomb Optical Company, Rochester, N. Y.

Potentiometers
Null and Deflection Potentiometers for Calibrating Meters are illustrated in Cir. 7851C-G 75-428 recently sent out by the Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia, Pa.

Radio Instruments
Radio Instruments and Radio Testing Instruments are described briefly in Circular J and Circular V respectively. These are issued by the Weston Electrical Instrument Corporation, Westerly Park, Newark, N. J.

Says the Fireman
This is the title of a recent direct mailing of the Republic Flow Meters Co., 2240 Diversey Parkway, Chicago, Ill.

Scale
A Desk Type Direct Reading Quadrant Type Scale is described in Circular 8 issued by the Amthor Testing Instrument Company, 309 Johnson St., Brooklyn, N. Y.

Scale
A Pocket Type Direct Reading Quadrant Scale is the subject of Circular No. 7 of the Amthor Testing Instrument Co., 309 Johnson Street, Brooklyn, N. Y.

Tachometer
The Efficiency Hand Tachometer is shown in a leaflet of the Amthor Testing Instrument Co., 309 Johnson Street, Brooklyn, N. Y.

Tensile Strength Tester
Circular No. 9 issued by the Amthor Testing Instrument Company, 309 Johnson St., Brooklyn, N. Y., describes and illustrates their new Motor Driven Tensile Strength Tester.

Tachometers
Reliance Tachometers manufactured by Barbour Stockwell Company, 205 Broadway, Cambridge, Mass., are described in their recent leaflet. These instruments can be arranged to meet individual requirements.

Testing Machines
Material Testing Machines manufactured by Mohr & Federhaff, Mannheim, Germany, are illustrated in Prosp. No. 1012. The captions of the illustrations are given in German, English, French and Italian.

Textile Testing Machinery
Catalogue No. 238 describes and illustrates the Schopper Textile Testing Machinery. This literature is distributed by H. Z. Schnewind, 72 Duane Street, New York, N. Y.

Toolmakers' Microscope
Catalogue E 36, IX-27 issued by the Bausch & Lomb Optical Co., St. Paul St., Rochester, N. Y., takes up the advantages of the optical method of measuring. A description of the Toolmakers' Microscope is also given.

Tools & Gauges
"What Do You Consider When Buying Tools," is the title of a leaflet issued by Brown & Sharpe Mfg. Co., Providence, R. I.

Trouble Shooting in the Heating Plant
is the title of a paper given before the Western Warm Air Furnace and Supply Ass. at Chicago. Reprints of this paper as it appeared in the Sheet Metal Worker are available for distribution by the Hays Corporation, Michigan City, Ind.

Vibrometer
The C. F. R. Giesler, Ltd., 58C Grays Inn Road, Holborn, London W. C. 1, England, have issued a leaflet on the Vibrometer. This apparatus is used for measuring vibrations, vertical and horizontal oscillations being measured separately.

Vibrometer
A leaflet on the Vibrometer has been issued by Carl Schenck, Darmstadt, Germany. This leaflet is printed in German.

Viscosimeter
Sup. 79-3M-6-26 issued by Arthur H. Thomas Co., West Washington Sq., Philadelphia, Pa., covers the Improved Model Stormer Viscosimeter.

Voltmeters
The New Weston Pin Jacket Voltmeter and the Weston Miniature A.C. Voltmeters are taken up in Circular V and Circular T respectively, issued by the Weston Electrical Instrument Corporation, Waverly Park, Newark, N. J.

Film Speed Indicator
Barbour Stockwell Company, 205 Broadway, Cambridge, Mass., has issued a leaflet on the Blanchard Film Speed Indicator for indicating motion picture film speed.

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Current Literature Review

Abstracts on instruments of interest to instrument readers

Temperature Measurements of Hot Flowing Gas. K. M. Watson and O. L. Kowalke. Gas Age-Record Apr. 21, 1928, pp. 541-544-550-556.

The apparatus for the temperature measurement of a Flowing Gas is illustrated and described.

The Inductive Method of Geophysical Prospecting. J. J. Jakosky. Can. Min. Apr. 20, 1928, pp. 327-329.

The article is the final one of a series. It takes up the final determination of conductor location.

Expansion Measurements at Low Temperatures. (Ausdehnungsmessungen bei tiefen Temperaturen). H. Ebert. Zs. Phys. Mar. 16, 1928, pp. 712-722.

The Henning Apparatus for the expansion measurements to the temperatures of liquid hydrogen is described. The expansion coefficient down to these temperatures is determined on different metals, glasses and porcelains.

On the Measurement of the Electrical Resistance of Porous Materials. A. E. Knowler. Prac. Phys. Soc. London. Feb. 15, 1928, pp. 37-40.

A method is described whereby the resistance of a material is measured independently of that at the surfaces in contact with it. The method is suited to the measurement of the resistance of ceramic, refractory, and building materials. Results show that the conductivity of a building stone is nearly proportional to its moisture content.

A Calorimeter for the Determination of the Heat Developed by Fruit. Ezer Griffiths. Prac. Phys. Soc. Lond. Feb. 15, 1928, pp. 46-53.

A calorimeter for measuring the heat evolved by apples during the senescence stage is described.

On the Construction and Standardization of an Interferometer Pressure Gauge. J. J. Manley. Prac. Phys. Soc. Lond. Feb. 15, 1928, pp. 57-61.

This paper deals with the application of the Michelson interferometer to the determination of gas pressures ranging from 0.0001 to 20 mm of Hg. The construction of the instrument is fully described as are also the methods used for standardizing the registering micrometer screw and its graduated head. The gauge can be instantaneously set and the pressure which is obtained at the moment of setting measured at leisure.

Demand Metering Equipment, Its Application in Recent Developments. S. Stokes and L. V. Nelson. Jl. A. I. E. E. April, 1928, pp. 262-265.

Abridgement of paper given at the Regional Meeting at St. Louis, March, 1928. The installation described is believed to be the largest of its kind. It required a very exacting study of all factors and operating results. Novel scheme incorporated in daily routine of handling demand meter tapes.

Accuracy in Large Machine Tools. H. K. Smyth and W. C. Wais. Amer. Mach. April 5, 1928, pp. 581-583.

The use of various measuring instruments and gages on large machines is taken up.

Diffusibility of Gas as Applied to the Estimation of Mine Gases. H. T. Ringrose. Coll. Guard. March 23, 1928, pp. 1131-1133.

A paper read before the Leeds University Mining Society. It reviews briefly the principles of the various apparatus suggested for measuring methane.

Improving Boiler Room Operation. Otto de Lorenzi. Combustion. April, 1928, pp. 249-252.

In this article, which is the second of the series, the value of test data is analyzed, and the instruments used in boiler room operation are described and their care and application indicated.

Instrument Developed for Measuring Cracks in Concrete. H. L. Bosley. Concrete. April, 1928, p. 32.

Illustration and details of operation given.

Fluid Governors for Prime Movers. I-Historical. Henry F. Schmidt. Elec. Jl. April, 1928, pp. 168-171.

Parson's governor, Stumpf governor, Ehrhott's centrifugal pump-type governor, Reichenbach's governor, Cartwright's governor, Smoot's fluid governor and Sulzer Bro.'s fluid governor illustrated.

Scientific Study of Piano Wire Produces Perfect Tone. J. B. Pletcher. Ir. Tr. Rev. Apr. 12, 1928, pp. 937-939.

Article describes research carried out on the behavior of music wire under stress of vibration. An instrument is illustrated which picks up the sound of the piano wire, and the electric impulse actuates a modified type of an oscillograph, which visualizes the wire's vibration.

The Sun Dial and Its Construction. H. B. Curtis. Pop. Ast. April, 1928, pp. 211-214.

Information on a Very Sensitive Measuring Instrument for Heat Radiation.

The construction and setting up of the sun dial is taken up.

(Ueber ein hochempfindlichs messinstrument feur Waermestrahlung.) G. Hettner. Zs. Phys. March 6, 1928, pp. 499-508.

The author's radiometer theory gives a viewpoint, which permits increasing the sensitivity of the radiometer considerably. The instrument is then described.

Measurements of Contact Potentials Between Metals in Vacuum. (Messungen von Kontaktpotentialen zwischen Metallen in Vakuum.) G. Moench. Zs. Phys. March 6, 1928, pp. 522-541.

The article describes two methods for the determination of contact potentials in high vacuum. The contact potential between different metals before and after annealing is measured.

The Inductive Method of Geophysical Prospecting. J. J. Jakosky. Can. Min. April 13, 1928, pp. 311-313.

This is part 2 of the article and takes up: Effects of Phase Relationship between Primary and Secondary Fields; Distortion of Wave-Front; Distortion of Primary Field; Phantom Dips and Field Data and Method of Plotting Results.

A Modification of the Rayleigh Disc Method for Measuring Sound. L. J. Sullivan. Phil. Magazine. March, 1928, p. 615.

This article discusses a method of using the Rayleigh disc to measure sounds of varying amplitude and in forms. In particulit the most suitable design. M. S.

Measurement of Vacuum-Tube Capacities by a Transformer Balance. Harold A. Wheeler. Prac. Inst. Radio Engrs. Apr., 1928, pp. 476-481.

A complete, portable equipment is described for the measurement of the direct capacities of vacuum tubes in laboratory or factory testing. The tube capacity is compared with a standard variable condenser by means of a transformer balance circuit, whose balance is independent of the frequency.

A Bridge Method for the Measurement of Inter-Electrode Admittance in Vacuum Tubes. E. T. Hoch. Prac. Inst. Radio Engrs. April, 1928, pp. 487-493.

A description is given of the Colpitts-Campbell bridge as applied specifically to the measurement of direct admittances in vacuum tubes. Data are given on several tubes.

Transmission Line Surges and Their Effect on Operation. Joseph H. Cox. Elec. Light. April, 1927, p. 24.

Part I. A study of voltage surges by means of the Klydonograph.

Leveling With An Aneroid. G. Hearn. Eng. Mar. 23, 1928, pp. 324-325.

This is the conclusion of an article which considered the use of an aneroid barometer for surveying preliminary to the use of other instruments.

The Work Meter. Eng. Mar. 23, 1928, pp. 328-330.

The instrument is to measure the working of machinery. The principle consists of using an electrical contact maker which is fitted to some part of the machine, and which at the end of every so many revolutions of the machine sends an impulse to a distant recorder.

Ground Resistance Testing. W. B. Craigmile, El. World. April 28, 1928, pp. 861-862.

New method of investigation described. Instruments and test procedure outlined. Results of tests and analysis of operation indicated.

Notes on Magnetic Orientation. N. E. England. Coll. Guard. Apr. 13, 1928, pp. 1429-1430.

The article discusses the use of the compass in the orientation of underground workings. The variations are discussed. Choice of Surface Station. Correction for diurnal variation. Orientation at Altofts Collieries.

Scottish Moulding Sands. F. Hudson. Foundry Trade Jl. April 12, 1928, pp. 262-266.

The ideal sand. Methods used in testing. Texture. Green sand testing. Dry sand and loam testing. Some common Scotch moulding sands. (To be continued.)

Standard Liquids for Viscosimeters. D. Krueger. Zs. Angew. Chem. April 14, 1928, p. 375.

Solutions for calibration of viscosimeters are discussed.

Safety Devices for Aircraft. M. L. Bramson. Jl. Royal Aero Soc. April, 1928, pp. 247-263.

Analysis of flying dangers. Classification of accidents. The Rohrbach Device. The de Havilland Differential Aileron Control. The Savage-Bramson Anti-stall gear. The Hanley-Page slot. Engine failure. Structural failure. Reid turn indicator. Weather dangers. Wireless direction finding.

Meter Repairing. Thos. C. Lynch. Jl. Amer. Waterw. Ass., April, 1928, pp. 392-394.

Method of repairing, accuracy required and cost briefly covered in this article.

The Graphic Water Level Recorder. C. C. Covert. Jl. Amer. Waterw. Ass. April, 1928, pp. 395-401.

Location of gaging station. Type of gage. Method of making discharge measurement. Measuring small streams.

Integrating Electricity Meters. E. Fawssett. Jl. Inst. Elect. Engrs. April, 1928, pp. 443-447.

D. C. energy meters. D. C. ampere-hour meters. Single-phase induction meters. Polyphase induction meters. High-tension metering. Summation meters. Demand indicators. Printer meters. KVA meters. Special apparatus. Time switches. Slot meters.

MEASUREMENT

THE president of one of the largest public utilities recently spoke on the strenuous efforts necessary to maintain a constant search for improved methods and improved service. A commercial or manufacturing organization is spurred on by competition, and accomplishments can be measured to some extent by watching the monthly sales and monthly profits, as compared to the general progress in the industry. Many public utilities have no clearly defined competition, and do not establish standards by which to measure their internal progress. Their external progress is shown clearly enough, by increase or decrease of output and income.

The best spur to progress is the use of figures to show comparative efficiency. The remarkable progress in the electrical industry can be traced in many ways to the exact figures on efficiency which are provided. The electrical engineer starts out with a given weight of coal and obtains an accurate figure on the number of B.t.u.'s per pound. When this coal is burned under the power plant boilers he is able by means of coal weighing apparatus, water and steam flow meters, to show how many B.t.u.'s have been used effectively in converting the water to steam at a given pressure. From the amount of steam used by his prime movers and by determining the electrical output of his generators he can figure the efficiency of his plant from the raw fuel starting point right through to the electrical energy delivered to the power house switchboard.

A constant study of efficiency in various steps has indicated the places where improvement can be made and has enabled the electrical engineer to concentrate on the problems which offer the greatest return. Furthermore, one steam electrical power plant can be compared with another, which makes it possible for the engineer to determine whether his plant is operated efficiently as compared to other plants of corresponding size with corresponding equipment.

In the gas industry, greater efficiency is dependent upon more accurate measurement. In the natural gas fields the production from every well should be measured, and the gas should be measured again at every important transmitting or distributing point.

As the gas company is paid by measurement at retail points, special care has been given to this problem and the amount of gas finally delivered and paid for is usually established in a satisfactorily accurate manner. The biggest loophole in most natural gas systems is the failure to measure at all points, from the original sources, right through to the final delivery. One of the largest natural gas companies is measuring all the gas which is purchased, but does not measure the gas from its own wells. If suitable apparatus were used on all wells there would be a slight increase in the capital investment, but the companies that have

installed measuring devices, and used them, will testify to the fact that the reduction in unaccounted-for-gas will offset many times this additional capital charge.

In the manufactured gas industry it is customary to measure the gas output of various stations, but there are very few gas companies which can claim to measure the gas throughout the system in such a way that the lost gas can be allocated to the various departments, so that each department can concentrate on its own deficiency. It is difficult, if not impossible, to lay out and plan the expansion in various sections of the community, unless gas is measured at each important distributing point. The demand attachment for large gas meters is a great aid in planning extensions, or in determining satisfactory industrial rates. Only a few gas companies use demand meters, but practically all large electric companies use them in industrial plants, both to study load conditions and to establish equitable rates.

One of the greatest lessons the gas industry can take from the electrical industry comes under the subject of measurement. Measure the input, measure the output, and obtain the efficiency. Find the overall efficiency and then find the efficiency of each producing, generating, transmitting, or distributing unit; concentrate on the low efficiency point and the overall efficiency will rise rapidly.

It is a notable fact that every important American Gas Association conference converts a few more engineers and executives to the theory that accurate measurement is essential to both engineering and commercial success.

W. F. R.
Gas Service Journal.

The New Subscription Form

IN order to facilitate the work of classifying our subscribers according to the kinds of instruments in which they are interested, we have revised the subscription form. The new form will be found in back of the book in front of the file cards.

Another new feature of this form is the back. All old and new Subscribers are urged to cooperate with us by filling out the back of the form and sending it to us.

A special subscription list, to contain 10,000 names, is now being started. Those individuals who return the subscription blank, which is bound in the back of the book, completely filled out on both sides, marked *special* across the face and enclose the same with a letter to us requesting that their name be placed on this list, will receive all special issues of INSTRUMENTS.

Radio Direction Finding. F. A. Kolster. Mar. Engg. May, 1928, p. 253.

Review of the development of radio direction finding shows remarkable growth in its application. Increased efficiency in transmission sought. Visual indicator developed.

Various Methods of Connecting Indicating Wattmeters. Part I. John Auchincloss. G. E. Rev. May, 1928, pp. 257-263.

Three-phase, three-wire circuits. Three-phase, four-wire circuits. Single-phase and polyphase instruments. Various combinations of current and potential transformers. Power factor and voltage balance considerations.

A Simple High Frequency Vacuum Furnace for Laboratories. (Ein einfacher Hochfrequenz—Vakuumofen fuer Laboratoriumszwecke.) E. W. Fell. Archiv fuer Eisenhuettenwesen. April, 1928, pp. 659-661.

Description of a vacuum furnace with high frequency heating for the production of pure metal melts. Arrangement for the addition of solid and gaseous materials.

An Improved Fast Method to Determine the Gases in Metals, Especially Oxygen In Steel. (Ein verbessertes Schnellverfahren zur Bestimmung der Gase in Metallen, inbesondre des Sauerstoffs in Stahl.) W. Hessenbruch and P. Oberhoffer. S. u. E. April 12, 1928, pp. 486-487.

Abstract of Report 54 of the Chemists' Committee of the German Iron and Steel Institute. Apparatus is illustrated and described.

A Method for Accurate Determination of the Specific Heats of Salt Solutions Up to 80°. Frank T. Gucker, Jr. Jl. Amer. Chem. Soc. April, 1928, pp. 1005-1016.

An adiabatic twin calorimeter apparatus has been developed. It is compact and provides greater uniformity in the environment and greater sensitivity in the thermal circuit. The method of standardization has been improved and greatly simplified. It is no longer necessary to determine the sensitivity of the thermo-elements galvanometer system or the heat capacity of the calorimeters.—M. E. H.

A Micro Calorimeter. S. G. Lipsett, F. M. G. Johnson and O. Maass. Jl. Amer. Chem. Soc. April, 1928, pp. 1030-1033.

A small calorimeter is described with which heats of solution may be determined using 4 cc. of solvent and corresponding amounts of solute. The heat capacity of the calorimeter is about 1 cal.—M. E. H.

The Measurement of the Conductance of Electrolytes. I. An Experimental and Theoretical Study of Principles of Design of the Wheatstone Bridge for Use with Alternating Currents and an Improved Form of Direct Reading A. C. Bridge. Grinnell Jones and Roswell Colt Josephs. Jl. Amer. Chem. Soc. April, 1928, pp. 1049-1092.

The specifications of an ideal resistance box are described in detail; two new resistance boxes superior to any on the market for this purpose were built and are described. A new form of bridge also has been constructed and is direct reading, sensitive to one part in a million, and possessing many other points of superiority, according to the claims of the authors.M. E. H.

An Improved Glass Manometer. Farrington Daniels. Jl. Amer. Chem. Soc. April, 1928, pp. 1115-1117.

A device for measuring the pressure of a gas entirely enclosed in glass is described. A measured air pressure is balanced against the pressure of the enclosed gas through a glass diaphragm and the point of balance is obtained by closing an electrical circuit through a platinum contact fused to the diaphragm.—M. E. H.

The Technical Requirements and the Limits of Roentgen Ray Penetration. (Die technischen Erfordernisse und die Grenzen der Roentgendurchstrahlung.) O. Morgenstern. Siemens Zs. Feb., 1922, pp. 62-69.

The equipment requirements are briefly taken up. The penetration through aluminum and iron is given for various current strengths.

The Development of Extensometers for Small Lengths. (Beitrag zur Entwicklung von Dehnungsmessern kleiner Messlaenge.) Kurt Boettcher. Zs. Inst. April, 1928, pp. 178-187.

Continued from page 125, March issue. The new extensometer is described and illustrated by means of drawings and photographs. This article is continued.

Optical Amplifiers. (Optische Multiplikatoren.) S. J. Turlyghin. Zs. Inst. April, 1928, pp. 187-191.

Refraction at the surface of two bodies. Reflection. Diagrammatic representation of the working of the instrument.

The Chemical Testing of Materials. (Die Chemische Pruefung der Werkstoffe.) J. Hausen. Messtechnik. March 22, 1928, pp. 59-62.

The importance of chemical analysis of materials. History of metal analysis. Chemical analysis as material testing and as operation control. Sampling. Analytical analysis methods. New developments. Chemical analysis of insulation materials, illustrated by rubber analysis. Corrosion tests, methods of carrying out in the laboratory and in practice. Special corrosion test methods.

Optical Telegraphy Involving the Rapid Transmission of Signals. (Telegraphie optique a ecoulement rapide des signaux.) M. Fournier. (Meeting of the Societe Francais des Electriciens. Feb., 1928.) Abstr. in Genie Civil. Feb. 11, 1928, p. 148.

Description of an optical method of communication over distances of from 3 to 10 km. with a speed approaching that of wire telegraphy and involving the use of selenium cells.—O. W. E.

A Simplified Manometer for Vacuum Distillations. G. B. Heisig. Ind. Engg. Chem. April, 1928, pp. 382-383.

This manometer obviates the possibility of contamination by condensed vapors of the mercury meniscus.—M. E. H.

Pure Food Gelatin—Physical Properties Related to the Economy of Manufacture. M. Briefer and J. H. Cohen. Ind. Engg. Chem. April, 1928, pp. 408-413.

Apparatus for the determination of jelly consistency and for the measurement of turbidity is described.—M. E. H.

A Micro-Fractionating Column for Analytical Purposes. C. M. Cooper and E. V. Fasce. Ind. Engg. Chem. April, 1928, pp. 420-421.

By means of this apparatus, a satisfactory separation between liquids of boiling points 10 degrees apart can be effected, using a 10 cc. sample. A diagram is given.—M. E. H.

Apparatus for Measuring the Hydrogen-Ion Concentration of the Soil. R. H. Bray. Ind. Engg. Chem. April, 1928, pp. 421-423.

A simple hydrogen electrode based on a combination of ideas used in other electrodes has been devised which gives quick and accurate results. The soil is kept in suspension during the measurement.—M. E. H.

Application of the Photo-Electric Cell to Automatic Titrations. Ralph H. Muller and Herman M. Partridge. Ind. Engg. Chem. April, 1928, pp. 423-425.

A circuit is described for the performance of automatic titrations. The solution being titrated by virtue of its color controls the amount of light that falls upon a photo-electric cell. The photo-current is amplified by a thermionic vacuum tube and actuates a relay, which in turn controls a buret release. Any sudden change in color can be made to operate the device by setting the relay. The control is applicable to large scale processes also.—M. E. H.

The "Homeos"; a New Stereo-Photographic Apparatus. M. Henrard. (Meeting of the Societe d'Encouragement pour l'Industrie Nationale. Jan. 28, 1928.) Abstr. in Genie Civil, Feb. 18, 1928, p. 170.

A description of a camera designed to take stereoscopic views 19x24 mm. dimensions on cinematographic films of standard size.—O. W. E.

Essentials in the Valuation of Fuels for Use in Internal Combustion Engines. (Les elements d'appreciation d'un carburant pour moteurs d'explosion.) E. Davin. Genie Civil. Feb. 11, 1928, p. 140.

The characteristics of certain fuels are described and brief reference is made to methods whereby these characteristics may be quantitatively measured.—O. W. E.

Electro-Capillary Microphone. (Microphone Electro-Capillaire.) M. Latour. Comptes Rendus. Jan. 23, 1928, p. 223.

A description of a simple microphone depending for its action upon electro-capillarity.—O. W. E.

Automatic Machine for Polishing Optical Glass. (Machine a translations epicycloidales automatiques pour surfacer les verres d'optique.) C. Deve. Comptes Rendus. Feb. 27, 1928, p. 567.

A description of a machine manufactured by l'Institut d'Optique in which the satisfactory results obtained in manual polishing are realized by mechanical means involving epicycloidal movements of the tool or glass.—O. W. E.

The Possibility of Obtaining an Electric Watch. (Les possibilites de realisation d'une montre electrique.) G. Malgorn. Genie Civil. March 3, 1928, p. 212.

Descriptions (fairly complete) of small electric pendulums and other electrical devices which are now being applied in the manufacture of electric watches to which the trade name "Ato" has been given.—O. W. E.

Water Measurement and Water Meter Testing Methods. (Wassermessung und Wassermesser-Pruefmethoden.) A. Baese. Wasser und Gas. May 1, 1928, pp. 764-799.

This article mentions the importance of measurement. Discusses the primary devices. Remote indicators and recorders. Meter checking and testing.

The Measurement of Low Air-Velocities in Mines. J. P. Rees. Trans I.M.E. April 1928, pp. 359-375.

The need for the measurement of low air-velocities in mines is discussed. The Windmill Type anemometer. Methods of measuring low air-velocities: Direct measurement using a smoke or dust cloud; by measuring the pressure exerted by the air due to its velocity; by measuring the rate at which heat is removed from a heated body exposed to an air current. Instruments employing the pressure effect: curved tube manometer; torsion anemometer: Owen low-speed vane anemometer; Kata thermometer; hot-wire anemometer. Record of velocities at the coal face. Calibration of the torsion anemometer.

An Automatic Recorder for Measuring the Strength of Radio Signals and Atmospheric Disturbances. E. B. Judson. Proc. Inst. Radio Engrs. May 1928, pp. 666-670.

Description of apparatus for automatically recording the field strength of low-frequency stations and atmospheric disturbances is given. Calibration can be made at any time from either a

Information Section

Correspondence from instrument users and others pertaining to or relative to instruments

THIS section invites correspondence from instrument users and others relative to questions pertaining to instruments.

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Inquiries regarding instrument problems will be answered by publication in this special "Information Section" of INSTRUMENTS. We feel that other besides the inquirers may be interested in the same or similar problems, and in this way all of our readers will obtain the benefit of the information furnished.

No. 2. Can you put us into communication with the manufacturers of the Howard-Dolman Depth Measurement Instrument?—E. F. H.

No. 14. Who is a maker of an indicating or recording instrument for chlorine gas mixture with N_2, O_2 and possibly some H_2O? The chlorine content varies from 0—50%.—T. C. W.

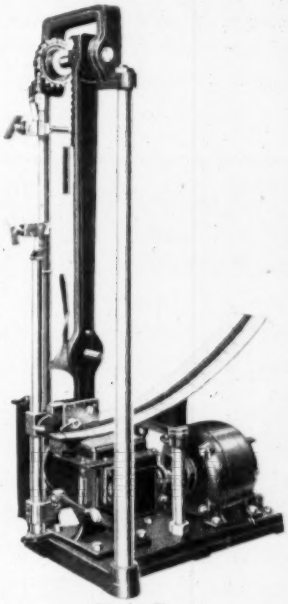
No. 15. We are looking for a device to indicate and possibly record low pressure differences. The values range from zero to 25 millimeters of water and we desire to read the pressures to one tenth millimeter fairly accurately.—A. A. G.

No. 16. Could you send us the names of dealers who handle apparatus for measuring linear expansion, particularly the linear expansion of thin metal foils?—D. H. H.

No. 17. Kindly send me the names of manufacturers of instruments for measuring and recording the flow of unscreened sanitary sewage.—E. T. O.

No. 18. We would like to know if there is any instrument now in production that can be used for determining the density of our plastic composition as it is about ready to be taken from the mixing machine and just prior to the pressing operation. The material is made from asphalt using dry, inert fibres and fillers of a mineral character. The plastic reaches a temperature as it thickens up into a doughy shape of approximately 450° F. It is substantially a heavy plastic dough.

No. 19. Could you send me the name of a company manufacturing an instrument for determining the moisture content in wool fibre?—R. W. V.



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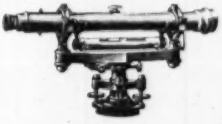

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radio-frequency or audio-frequency source. Typical curves of the variations in signals and atmospheric disturbances are shown.—A. W.

A Thermal Method of Standardizing Dielectric Power Loss Measuring Equipment. J. A. Scott, H. W. Bousman and R. R. Benedict. Jl. A.I.E.E. May 1928, pp. 361-364.

This paper briefly reviews the need for reference standards in dielectric power loss measurements at high voltage and commercial power frequencies. It describes a thermal method for measuring dielectric power loss in cable, utilizing the sheath temperature rise associated with the flow of heat due to the power loss within the sheath. Sources of error as briefly discussed and results are given in comparison with measurements of dielectric power loss by the reflecting astatic electrodynamometer wattmeter, using an air capacitor for phase-angle compensation.—Ha.

Fluid Governors for Prime Movers. II—Type Characteristics. Henry F. Schmidt. Elect. Jl. May 1928, pp. 238-242.

Effect of temperature and atmospheric pressure. Methods of compensating for physical characteristics of media. Method of supplying fluid to the pump.—Ha.

A Glowing Filament Oscillograph for Vacuum Exposures. (Ein Gluehkathodenoszillograph fuer Vakuumaufnahmen.) W. Rogowski and K. Baumgart. Arch. Elekt. Mar. 15, 1928, pp. 521-526.

The instrument is described and illustrated. Results are also illustrated.—Ha.

Precision Methods in Radioactivity. L. Bastings. Jl. Scient. Inst. April 1928, pp. 113-122.

The simplest type of insensitive gold-leaf electroscope, as used in radioactive work, is critically and experimentally investigated with a view to increasing the accuracy of measurements made with this instrument. Results are quoted, showing a consistency of the order of 1 in 1000; and highly accurate comparisons are shown to be possible between radioactive sources of widely differing magnitudes.—M. B. R.

An Instrument to Record the Carbon Dioxide Content of a Gaseous Mixture. K. Gordon and J. F. Lehmann. Jl. Scient. Inst. April 1928, pp. 123-126.

The carbon dioxide recorder described in this paper is based on the variation in concentration of the bicarbonate salt in equilibrium with a saturated solution of the carbonate of an alkaline earth, preferably barium. The bicarbonate concentration is dependent upon the carbon dioxide partial pressure in the gas passed through the solution, and is measured by determining the electrolytic conductance of the solution. By using a recording A.C. milliammeter to measure this conductance a continuous record is obtained of the carbon dioxide in the gas. The readings of the instrument are independent of the gaseous constituents other than carbon dioxide. It can therefore be used when other recorders are inapplicable owing to the simultaneous variation of several constituents of the gas to be analyzed.—M. B. R.

A Method of Calibration of a McLeod Gauge. R. J. Clark. Jl. Scient. Inst. April 1928, pp. 126-130.

A method of construction of a gauge of long range is described, and also a method of correcting for the error due to the meniscus in the capillary tube by shifting the whole scale of the instrument.—M. B. R.

Apparatus for the Determination of Coefficient of Expansion. J. W. W. Willstrop. Jl. Scient. Inst. April 1928, pp. 130-132.

Apparatus is described and illustrated.—M. B. R.

A Simple Control Unit for Electrically Heated Mercury Vapor Pumps. D. R. Barber. Jl. Scient. Inst. April 1928, pp. 133-134.

This control is described.—M. B. R.

Qualities of Bitumens and Road Tars. H. S. Graves. Can. Eng. May 15, 1928, pp. 528-530.

Various tests on bitumens and tars described. Specific gravity. Ductility. Penetration test. Viscosity test. Bitumen solubility. Tar distillation. Durability. Distillation tests. Fusing point tests.—M. B. R.

An Electrical Method for Measuring Setting Time of Portland Cement. Y. Shimizu. Concrete, May 1928, pp. 111-113.

The change in electrical resistance which occurs during the setting and hardening of portland cement has been measured for the purpose of determining the setting time. The effect of temperature on the rate of setting of portland cement has also been studied.—M. B. R.

Simple Method for the Determination of the Electrostatic Capacity of Electroscope. R. B. Taft. Radiology, March 1928, pp. 257-258.

The relative effects of exposure to radium on the rate of fall of the leaf with and without a standard capacity connected to the electroscope enable the capacity of the electroscope to be determined by a simple calculation.—Abs. Bull. Kodak Res. Lab.

The Two-Watt Meter—Process in Practice. (Des Zweiwattmeter Verfahren in der Praxis.) F. Kelbe. A. E. G. Mett. April 1928, pp. 172-177.

A new accessory for the output meter, manufactured by the meter plant of the A. E. G. is described.

Improved Method of Visualizing and Photographing the Dielectric Field. R. H. George, K. A. Oplinger and C. F. Harding. Bull. Purdue Univ. No. 29, Enggr. Exp. Sta.

Two methods and their necessary accompanying technique are described.

Sensitivity Determination Without a Densitometer. F. Formstecher. Phot. Chronik. Feb. 7, 1928, pp. 50-51.

The Eder-Hecht sensitometer of wedge constant 0.4 is used for negative, and the printing photometer of wedge constant 0.3 for positive, materials. For inspection by transmitted light, as in the former case, the "sensitogram" (plate or film tested) is laid, gelatin film down, on the opal glass of a 32 c.-p. lamp illuminator in a dimly lighted room; and, allowing a definite time (e.g., 4 sec.) of inspection, the threshold reading is made by two observers in succession, and the mean accepted. The author's purpose is to show that practically unobjectionable results are obtained with simple materials (although not so easily and exactly as by means of, for example, the Goldberg detail plate).—Abs. Bull. Kodak Res. Lab.

Measurement of the Light-Sensitivity of Photographic Films. P. Wiegleb. Das Lichtbeld. Jan. 25, 1928, pp. 126-128.

This concluding installment contains an account of the methods of estimating speed by means of the neutral gray Goldberg-Hübl wedge and Eder-Hecht scale, with tables of comparison of Scheiner degrees with those of Hurter and Driffield, Watkins, Wynne, Warnerke, and Eder-Hecht.—Abs. Bull. Kodak Res. Lab.

Measuring the Speed of Focal Plane Shutters. C. Winther. Phot. Korr. Jan. 1, 1928, pp. 1-3.

An apparatus previously described by Hertzberg (Nord. Tids. Fot., 1917, p. 60) was improved to make it capable of measuring high-speed shutters. A beam of light interrupted by a sector wheel is made to produce a broken line on the plate when exposed through the shutter. Formula and tables are given relating the various factors.—Abs. Bull. Kodak Res. Lab.

The Case of the Extinction Meter. E. A. Bierman. B. J. Jan. 13, 1928, pp. 15-16.

Practical tests made under difficult lighting conditions, both indoors and outdoors, show that exposure meters working on the extinction principle are to be preferred to actinometers. In bright light, shadow detail must be extinguished completely, whereas in dull light shadow detail should be seen distinctly. Simplicity and rapidity in determining exposures are two valuable assets of extinction meters.—Abs. Bull. Kodak Res. Lab.

Roentgenographic Measurement of Objects by Means of Specially Constructed Standardized Screens Interposed Between Object and Film. G. W. Wagoner. Amer. Jl. Roent. Feb. 1928, pp. 170-172.

A cross-line screen is interposed between object and film, and dimensions of object are determined from knowledge of distances of object and screen from film and tube and sizes of shadows cast upon film.—Abs. Bull. Kodak Res. Lab.

A Water-Level Gage of the Long-Distance Recording Type. E. B. Strowger. Mech. Engg. May 1928, pp. 365-367.

This paper describes a water-level gage of the long-distance recording type, consisting essentially of two Selsyn motors, one called the transmitter and one the follower, together with a float and a recording device. The transmitter is located at the point of measurement and the follower at some central point where the record is to appear. The position of the rotor of the transmitter is controlled by a float. The follower motor operates a pen carriage which records on a paper with suitable scaled divisions. The motors are essentially induction motors with wound rotors excited from a common alternating-current source. The rotor of the follower will follow the transmitter rotor due to the induced currents in the stators.

Additional Information on the Measurement of Steam Quantities by Means of Orifices. (Beitrag zur Mengenmessung Stroemenden Dampfes Mittels Stauringen.) Walter Pflaum. Forschungsarbeiten auf dem Gebiete des Ingenieurwesens. Heft. 298 V. D. I.

This research, carried out at the mechanical laboratory of the Dresden Technical Institute, was undertaken to ascertain the condition under which orifice meters are accurate for measuring the flow of steam, and the effect of various sizes of orifices and pipes and methods of measuring pressure upon the results. The relations between the amount of steam and the size of orifice, static and differential pressure, etc., were studied thoroughly.

X-Rays: A New Tool in the Foundry. Iron Age. March 8, 1928, pp. 655-656.

Examination of X-ray before machining castings reveals hidden defects and reduces foundry costs; two cases cited; with gray iron or steel castings it is now possible to X-ray through thickness of 3½ in.; such flaws as blowholes, cracks, bubbles and foreign material are relatively easy to detect in one or two exposures; X-ray equipment of low cost utilized for aluminum-alloy castings; examining first run of castings.

Instruments for Measurement of Temperature. Power Pt. Engg. April 15, 1928, pp. 458-460.

The following types are mentioned: Glass thermometers, Pressure gage thermometers; Differential-expansion thermometers; Electrical resistance thermometers; Thermocouple pyrometers, Optical pyrometers, Radiation pyrometers, Fusion pyrometers, Calorimetric pyrometers and color temperature charts.

Testing the Refrigerating Plant. Part I. W. R. Woolrich. Power Pt. Engg. April 15, 1928, pp. 473-476.

Factors affecting tonnage. Measuring and weighing ammonia. Determination of heat balance.

Vibrations of Turbine-Generator Foundations. T. C. Rathbone. Power, April 3, 1928, pp. 588-592.

This article points out that the customary efforts to avoid resonance by design are quite insufficient, that most structures are too complex to predetermine the many modes of vibrations. Vibration studies. Modification of Vibrometer. Predetermination of natural frequencies.

Review of Recent Patents

Printed copies may be obtained at the cost of 10 cents by addressing the Commissioner of Patents, Washington, D. C.

INSTRUMENT FOR INDICATING DIRECTION OF FORCES. Charles H. Colvin, Brooklyn, N. Y. Pat. No. 1,667,840.

LOW PRESSURE INDICATOR. Joseph W. Legg, Wilkinsburg, Pa., assignor to Westinghouse Electric & Mfg. Co. Pat. No. 1,667,861.

INDICATING DEVICE. Clarence H. Hapgood, Toledo, O., assignor to Toledo Scale Co. Pat. No. 1,667,890.

ELECTRICAL MEASURING INSTRUMENT. Joseph Slepian, Swissvale, Pa., assignor to Westinghouse Electric & Mfg. Co. Pat. No. 1, 667,905.

GAS METER. Arno R. Huettig, Erie Pa., assignor to The American Meter Co., Inc. Pat. No. 1,668,078.

HOT-WIRE VACUUM METER. Walter D'Allenbach, Zurich, Switzerland, assignor to Aktiengesellschaft Brown, Boveri & Cie. Pat. No. 1,668,106.

MICROMETER ATTACHMENT. Robert W. Olson, Beloit, Wis. Pat. No. 1,668,248.

MEASURING APPARATUS. Walter G. Joy and Cecil R. Cherry, Cleveland, Texas. Pat. No. 1,668,370.

INDICATING DEVICE FOR ELECTRICAL APPARATUS. Edward D. Treanor, Pittsfield, Mass., assignor to General Electric Co. Pat. No. 1,668,388.

RATE-OF-FLOW INDICATOR WITH ELECTRIC INTEGRATION FOR FLUIDS AND GASES FLOWING THROUGH A VENTURI TUBE. Willy Kath, Berlin-Friedman, Germany, assignor to Siemens & Halske. Pat. No. 1,668,457.

PRESSURE REGULATOR. Herbert B. Morrill, Salem, Mass. Pat. No. 1,668,655.

INDICATING DEVICE. Hector Rabezzana, Flint, Mich., assignor by mesne assignment to A C Spark Plug Co. Pat. No. 1,668,732.

ELECTRIC METER. Henry R. Bartlett and Henry J. Blakeslee, West Hartford, Conn., assignors to The States Company. Pat. No. 1,668,798.

DECELEROMETER OR THE LIKE. William S. James, Berkeley, Calif. Pat. No. 1,668,809.

TEST INDICATOR. Gaylord G. Mackey, Detroit, Mich., assignor of one-half to Albert Loosli, Detroit, Mich. Pat. No. 1,668,857.

TEMPERATURE REGULATOR. Jean V. Giesler, Knoxville, Tenn., assignor by mesne assignment to The Fulton Silphon Co. Pat. No. 1,668,896.

LIQUID-LEVEL INDICATOR. Chas. W. Schirmer, Yonkers and Howard P. Wood and DeWitt D. Wood, Poughkeepsie, N. Y. Pat. No. 1,668,925.

THERMOSTATIC REGULATOR. August J. Mottlau, Pittsburgh, Pa., assignor to Westinghouse Electric & Mfg. Co. Pat. No. 1,668,973.

SEISMO-VIBROMETER. Karl Ludwig Kithil, Denver, Colo. Pat. No. 1,669,135.

ELECTRICITY METER. Jesse Harris, La Fayette, Ind., assignor to Duncan Electric Mfg. Co. Pat. No. 1,669,163.

ELECTRICITY METER. Frank Scott, La Fayette, Ind., assignor to Duncan Electric Mfg. Co. Pat. No. 1,669,277.

METER. John Henry Wiggins, Bartlesville, Okla. Pat. No. 1,669,315.

IMPEDANCE METER. Chas. E. Vawter, Philadelphia, Pa., assignor to Weston Electrical Instrument Co. Pat. No. 1,669,400.

HEAT SATURATION INDICATOR. Richard L. Fearn, Philadelphia, Pa. Pat. No. 1,669,510.

MEASURING DEVICE. Frederic W. Hild, Los Angeles, Calif. Pat. No. 1,669,519.

THERMAL CONTROL DEVICE. Christian Aalborg, Wilkinsburg, Pa., assignor to Westinghouse Electric & Mfg. Co. Pat. No. 1,669,544.

FLEXIBLE THERMOSTATIC ELEMENT. Walter H. Himes, Pittsburgh, Pa., assignor to Westinghouse Electric & Mfg. Co. Pat. No. 1,669,561.

ELECTRICAL MEASURING INSTRUMENT. Carl Oman, Swissvale, Pa., assignor to Westinghouse Electric & Mfg. Co. Pat. No. 1,669,572.

TEMPERATURE CONTROL SYSTEM. Stephen A. Staege, Pittsburgh, Pa., assignor to Westinghouse Electric & Mfg. Co. Pat. No. 1,669,582.

THERMOSTATIC SWITCH. Frank F. Forshee, Mansfield, Ohio, assignor to Westinghouse Electric & Mfg. Co. Pat. No. 1,669,608.

FLOW METER. James Walsh, Swampscott, Mass., assignor to General Electric Co. Pat. No. 1,670,089.

IRRIGATION METER. William L. Marden, New York, N. Y., assignor to Neptune Meter Co. Pat. No. 1,670,308.

DRIFT CALCULATOR. John Hays Hammond, Jr., Gloucester, Mass. Pat. No. 1,670,354.

THERMOMETER. Giuseppe Ioannes, Turin, Italy. Pat. No. 1,670,577.

SPEEDOMETER. Joseph Berge, Dayton, Ohio, assignor to A C Spark Plug Co. Pat. No. 1,670,836.

DEVICE FOR STRESS MEASURING OR TESTING. Walter A. Perkins and Warren W. Gayman, Sacramento, Calif. Pat. No. 1,670,981.

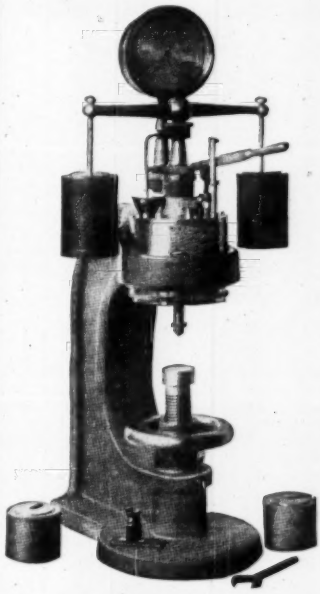
CANADIAN PATENTS

PYROMETER. Robt. C. Pairman, Berkeley, Calif. Pat. No. 279,773.

ELECTRICITY METER MECHANISM. Fred Kurz, Springfield, Ill., assignor to The Sangamo Electric Co. Pat. No. 279,843.

INDUCTION METER MECHANISM. Riccard Pudelko, Zug, Canton Zug, Switzerland, assignor to Landis and Gyr. Pat. No. 280,197.

SPEEDOMETER. Georges Mombur, Versailles, France. Pat. No. 280,301.



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The Business Manager's Page

Each month the Business Manager will have a message on this page.

To the Instrument Companies

INSTRUMENTS was established in January of this year to fill a definite need for a trade journal which would be devoted to the instrument problems of all industries, and present to its readers new and effective developments on instruments for use in science and industry. Given such a background, the instrument manufacturer is enabled better to serve those readers.

While this is but our sixth issue, we are pleased to state that it has been pointed out to us that at this early date INSTRUMENTS is being recognized and accepted as an authoritative and reliable source of information, for all those interested in increasing the efficiency of industrial operations in all industries through instrument applications.

The more than 10,000 copies each month are read by men interested in measurement, inspection and control, the engineers, metallurgists, chemists, etc. For the most part these men are in positions of authority and responsibility. Very often the same man has a definite buying power in more than one industry, or in more than one department of the same industry. Is it not important then, for companies who manufacture apparatus used in measurement, inspection and control, to place their sales message before these men? In every case you are reaching men of executive status whose business or professional connections are a record, and whose industrial buying power cannot be overestimated.

The following, taken from a contemporary, has this to say:

> "The careful buyer consults the practical men—the engineer, the metallurgists, and chemists, and the inspectors, before he buys."—C. W. Nash, in *Factory*, February, 1926.

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Below are standard file cards, which the editor believes will be a valuable asset to you personally. These cards will be bound in each issue of Instruments and will cover the original articles contained in that issue. The color of the card and ink to be used is shown here. This will facilitate distinguishing the INSTRUMENTS FILE CARDS from others with which they might be consolidated.

The editor suggests that these cards be carefully cut out immediately on receipt of INSTRUMENTS and filed in your desk or in a file box on top of your desk. You will then have within easy reach an index of instrument information of incalculable value.

The card is arranged with a space for classification subject or number at the top. Suggestions as to classifications for the cards below are:

CHECKING MACHINE TOOLS

X-RAY EXAMINATION

THE DETERMINATION OF THE PARALLELISM OF THE MEASURING SURFACES OF MEASURING TOOLS

DR. G. BERNDT, INSTRUMENTS, Vol. 1, No. 6, pp. 263-270, 12 figs.

The need for checking parallelism is briefly mentioned. The methods for determining the following are given.

1. Parallelism of measuring surfaces turned towards one another (vernier calipers, amplifying gauges, dial gauges, micrometers, and measuring machines), by the following methods a) light slit, b) by end measuring rods, balls, etc., c) inside test indicator, d) interference, e) auto-collimating telescope.

2. Parallelism of measuring surfaces turned away from one another (gauge blocks) by the following methods: a) amplifying gauge, b) interference, c) auto-collimating telescope.

3. Angles by means of auto-collimating telescope.

X-RAYS IN INDUSTRY

HERBERT R. ISENBURGER, INSTRUMENTS, Vol. 1, No. 6, pp. 271-273, 6 figs.

The three methods of X-ray investigation are mentioned. A table is given showing the exposure times for bronze, iron and steel, and aluminum. Illustrations of exographs of various materials and sections are given.

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A Device for Measuring the Brittleness of Rubber and Gutta Percha Compounds

G. T. KOHMAN and R. L. PEEK, Jr., INSTRUMENTS, Vol. 1, No. 6, pp. 275-279, 2 figs.

The instrument is described and illustrated. Temperature control and measurement is mentioned. Method of determining brittleness temperature is given. Brittleness temperatures of rubber and gutta percha compounds are listed. A modified form of the apparatus employed to determine brittleness temperatures under high pressure is also described.

A Proposed Automatic Spectrum Analyzer

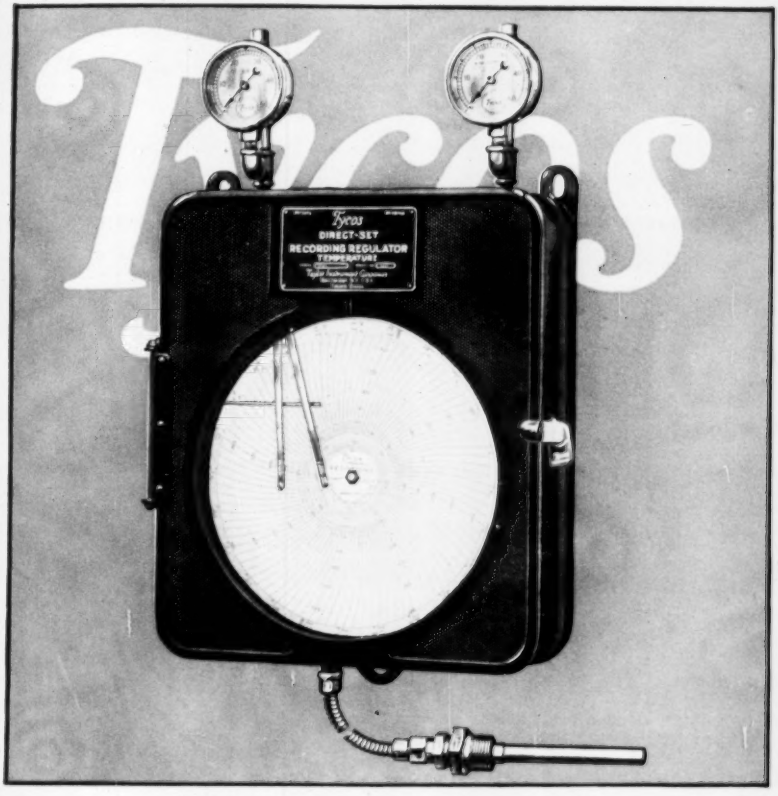
ARTHUR SCHRODER, INSTRUMENTS, Vol. 1, No. 6, pp. 281-283, 1 fig.

The proposed apparatus is described and illustrated. The uses of the apparatus are briefly given.

Eliminating Error with Spherical Points on Strain Gauge Levers

P. J. McCULLOUGH, INSTRUMENTS, Vol. 1, No. 6, pp. 283-284, 2 figs.

The change is described as applied to the Berry strain gauge.



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